Agricultural Operations

1929-30 to 1932-33

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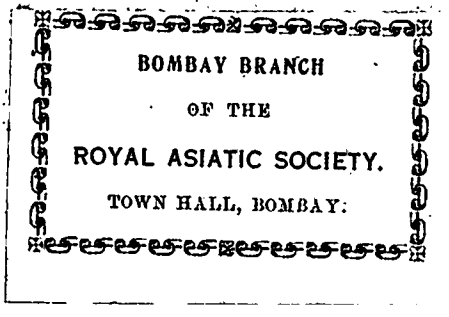

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Review of Agricultural Operations in India

1929-30 & 1930-31 and 1931-32 and 1932-33

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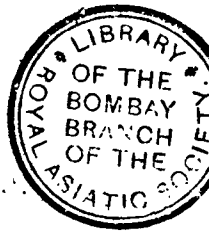

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PREFACE

After the publication of the Review of Agricultural Operations for the year 1928-29, the Imperial Council of Agricultural Research decided that the succeeding issues should be biennial. This Review, which accordingly deals with the years 1929-30 and 1930-31, is based on the annual reports from provinces and States, and the "Review of the Trade in India" for these two years. Some provincial reports deal with the agricultural year ending in June while others and the "Review of the Trade in India" deal with the fiscal year ending in March. In some instances information is included in the provincial reports for later portions of each year. These reports have appeared at various dates towards the end of 1930 and during 1931 and 1932 : the last provincial report was received in September 1932.

In this Review an attempt has been made to include all important information available during the two agricultural years 1929-30 and 1930-31, and the statistics quoted with the exception of those relating to exports and imports relate to these agricultural years.

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Review of Agricultural Operations in India, 1929-30 and 1930-31

CHAPTER I.

AGRICULTURAL CONDITIONS DURING 1929-30 AND 1930-31.

1. Agricultural Conditions.

1929-30

The rainfall of the monsoon of 1929 was adequate and generally well distributed, although heavy rains in places resulted in floods causing damage to the crops as in parts of Assam, the Punjab and Sind. Averaged over the plains of India, the rainfall during the main monsoon period was in defect by one per cent. During the retreating monsoon period the rainfall was in very large excess in Bihar and Orissa, the Punjab, Sind and Bengal, and in moderate excess in Assam and the North-West Frontier Province; it was nearly normal in Bombay, the Central Provinces, Mysore and Madras but in moderate to large defect elsewhere. Taking the year as a whole, the rainfall was within 25 per cent. of the normal except in Sind, where it exceeded twice the normal amount. In Assam, the excessive rains in June caused heavy flooding in both the Brahmaputra and Surma valleys and, even though a large proportion of the rice fields was resown after the subsidence of the floods, the unfavourable season that followed caused a marked decrease in the yield. In the Punjab, though the weather conditions were generally favourable, yet in the riverine and low-lying districts crops suffered considerably from heavy

floods, and excessive rains in July and the general dry months that followed were prejudicial to the maturing of the *kharif* crops. Sind received unprecedented rainfall, causing heavy flooding and resulting in great damage to crops, life and property. In the United Provinces the monsoon was below the normal. Rains were throughout insufficient in the western districts, while in the rest of the province poor rains in September followed by a dry October marred the *kharif* harvest and delayed the *rabi* sowings. Timely showers in December, however, relieved the situation and yielded in some places a bumper harvest. But the drought in the western districts was made more acute by an unparalleled visitation of locusts which caused havoc in no less than 17 districts and extended into the Punjab and Central India. A prolonged break in the monsoon between July and September affected adversely the *kharif* crops in Khandesh, the Karnatak and some districts of the Konkan in the Bombay Presidency, also in Guntur and the central districts of the Madras Presidency. Owing to the unsatisfactory distribution of the rains, the *rabi* crops were also more or less a failure in Khandesh and the Deccan. In Burma, the rainfall was abundant but badly distributed. At first conditions were promising, but the unusual break in the monsoon from the third week of October spoilt what would have been a bumper paddy crop in Lower Burma and had a disastrous effect on the later crops in Upper Burma.

The rice crop of the year was good although the yield was 4 per cent. less than the plentiful harvest of the preceding year. After an indifferent harvest in the preceding season, the wheat crop of 1929 gave a good outturn, which was 10 per cent. higher than in 1928. The yield of sugarcane too was slightly better. The cotton and jute crops were not as favourable as in the preceding season, the yield of the former being less by 9 per cent. and that of the latter by 2 per cent. Among oil-seeds, the outturn of the groundnut crop was 23 per cent. less than the record yield of the preceding season, although it was 34 per cent. above the average yield of the preceding five years. Rape and mustard gave an increased

outturn, but sesamum and linseed gave less than in the preceding season.

1930-31

The rainfall of the monsoon of 1930 was good and fairly well distributed throughout the country, although its activity in August was confined to Burma and North-East India. Averaged over the plains of India the total rainfall of the monsoon period was in defect by 2 per cent. The retreating period of the South-West Monsoon was characterised by an excess of rainfall over the whole country except in the Punjab, North-West Frontier Province and Sind where it was in moderate or large defect; in Burma and the United Provinces in slight defect; in Bengal and Central India normal. The total rainfall of the year as a whole was within 18 per cent. of the normal. In the Punjab, the climatic conditions were generally unfavourable for the *kharif* sowings. The rainfall in August and September, though below normal, proved useful for the standing crops, but locusts, hailstorms, dry winds and insects had an adverse effect on the yields in some places. The unusually dry weather proved to be unfavourable for *rabi* sowings, but the light rains in January, February and March, though insufficient, were welcome to the standing crops. Some damage was caused by frost in December and January and by the dry winds in March and April, but conditions proved to be favourable for harvesting operations. In the Central Provinces and Berar, the weather was generally propitious for the *kharif* crops. As for *rabi*, the season proved favourable in the Nagpur and Chhattisgarh Divisions but distinctly unfavourable in the North, in the Nerbudda Valley and Berar. The season was thus favourable and almost all the principal crops showed an increased outturn. The rice harvest of the year was plentiful and exceeded the previous year's good crop by about 2 per cent. The wheat crop of 1930 was a bumper one and its production was estimated at the record figure of over 10 million tons. Sugarcane gave a good yield which was 15 per cent. higher than that of 1929-30. Another good crop of jute was obtained in 1930, surpassing the previous year's crop by 8 per cent. The oil-seed crops of the year also showed an

increase as compared with the preceding season. Cotton alone gave a reduced outturn, being 8 per cent. less than that of the preceding year.

2. Economic Conditions.

The last fifteen years constituted a period of high prices of agricultural commodities. During this period remarkable progress was made in agricultural improvements through the efforts of both official and private agencies and there is no doubt that the earnings of the agriculturist increased greatly during this time, but unfortunately too little of this wealth went back into land improvements, better fed cattle and better houses and too much was spent in unproductive objects like litigation, dress and expensive food. Thus, when the period of world depression arrived, the agriculturist was not in a firm position to meet adversity. The depression, the worst experienced for very many years, started in 1929, deepened at an accelerated rate in 1930, and at the end of the period under review there was no definite indication that the bottom had been reached. In fact, during 1931-32 conditions became progressively worse. The principal causes of this world-wide depression as analysed by experts were overproduction in comparison with the normal rate of consumption, particularly in the case of raw materials ; the concentration of gold in creditor countries, chiefly America and France, resulting in the depletion of reserves and consequent, deflation ; and unsettled political conditions in many countries, notably India, China, Russia and South America. During the last twenty years great advance has been made not only in opening up new areas for growing crops and by increasing the efficiency of production, but also by the discovery of higher-yielding strains of plants and of means of resisting unfavourable conditions, diseases and pests. The increased production of foods and raw material has come about at a time when the demand for these products is abnormally inelastic.

One of the most important features of the depression was the phenomenal fall in prices that affected all countries alike. In order to show more clearly the fall in prices in the case of raw materials in India, the following table gives the wholesale prices of several

of them at centres where the prices are typical. It must be remembered of course that these prices are not those paid to the primary producer—such are usually much lower—but it is not possible with present knowledge to give exact figures for them. Still the prices recorded below give a clear enough concept of the disastrous fall :—

Fall in prices.

Commodities	April, 1929	October, 1929	April, 1930	October, 1930	April, 1931	Percentage decrease from April, 1929
	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	
1. Wheat, white, Lyallpur, per maund.	6 5 6	4 8 0	3 6 0	2 1 9	1 14 0	70
2. Rice, Ballam No. 1, Calcutta, per maund.	6 6 0	7 4 0	6 1 0	6 2 0	4 6 0	31
3. Cotton, raw, M. G. F. G. Broach, Bombay, per candy (784 lbs.).	354 0 0	344 0 0	272 0 0	202 0 0	198 0 0	44
4. Jute, raw, Firsts, Calcutta, per bale (400 lbs.).	68 8 0	60 0 0	49 0 0	30 0 0	28 0 0	59
5. Linseed, bold, Bombay, per cwt.	10 11 0	13 13 0	12 1 0	9 4 6	7 4 0	32
6. Groundnuts, decorticated, Madras, per candy (500 lbs.).	46 0 0	53 0 0	43 0 0	30 0 0	30 0 0	35
7. Sesamum, white, bold, Bombay, per cwt.	11 11 0	11 13 0	10 4 0	9 8 0	8 6 0	28
8. Castor seed, F. A., Bombay, per cwt.	10 8 0	10 1 0	9 8 0	7 15 0	7 0 0	33
9. Tea, sale average, Calcutta, per lb.	0 10 8	0 10 11	0 8 10	0 10 7	0 6 0	43
10. Sugar, Java, whites, 25 D. S. and higher, Calcutta, per maund.	9 8 6	9 5 6	9 1 9	8 11 6	8 15 0	6

It is seen that wheat, jute, cotton and tea suffered the greatest decline in prices and then came oil-seeds and rice. In the case of sugar the fall was small and the prices subsequently rose owing

to the increased duties imposed on foreign sugar in pursuance of the protective policy initiated by Government. The immediate effect of this heavy fall in prices of agricultural produce was the reduction of the purchasing power of the rural population, which constitutes 90 per cent. of the total population, and this was reflected in the huge reduction in the imports of manufactured articles. It also led to serious maladjustments in the transactions between landowners, tenants and labourers. Landowners who borrowed money for cultivation expenses found themselves in many cases without the wherewithal to repay. Tenants and labourers found their purchasing power much reduced and this evil was accentuated by the higher standard of living fostered by the years of prosperity, though in the case of the poorer classes some alleviation was provided by the low price of those agricultural commodities which are daily necessities of life.

Adjustment must come in time, but how soon it is impossible to forecast, and there is doubtless a considerable period of trouble to be faced. The effect of this state of affairs on the work of the Agricultural Departments must inevitably be serious in the near future, although it has not yet been felt appreciably except in the curtailment of the expansion of their activities.

3. The Imperial Council of Agricultural Research.

Mention was made in the last Review of the establishment of the Imperial Council of Agricultural Research by the Government of India. In years to come this will be regarded as an epoch-marking event in the history of agricultural improvement in India.

The Council held its inaugural meeting in June 1929 and passed its draft Memorandum of Association and Rules and Regulations. At this meeting representatives of the provinces reported the progress made by Provincial Governments in the preparation of schemes for assisting the sugar industry and decided to set up a Sugar Committee.

In this Committee the Council has a qualified and representative body to which it can refer all questions affecting the welfare of the sugarcane industry in India. During the period under

review the Committee, which had received a general mandate from the Council to examine and report on measures necessary for the development of the sugarcane industry in India, held three meetings. One of the first recommendations was that the Government of India should be asked to institute an enquiry through the Tariff Board in regard to the question whether protection should be given to the Indian sugarcane industry. This recommendation was accepted by the Council and the latter's representations were successful in inducing the Government of India to order such an enquiry. Pending full consideration of the Tariff Board's report, the Government of India had already taken action and raised the duties on imported sugar as from the year 1931-32. The Council has also accepted all the major recommendations of this Committee, for example, the establishment of a chain of sugarcane research stations embracing all the sugar-growing provinces of India, the appointment of a technologist whose advice is in great demand by existing and prospective sugar manufacturers in India and the endowment, in collaboration with the Government of the United Provinces, of a research sugar factory at the Harcourt Butler Technological Institute, Cawnpore.

From sugar the Council turned its attention to locusts. In 1929, the northern and north-western provinces of India were subjected to one of those periodic visitations which in a short space of time wipe out in the tracts concerned a whole season's work of the agriculturist. It was realised that there was little use in trying to cope only with a locust invasion once it was in full force but that efforts should rather be directed to deal with this menace in its initial stages so that it could be overcome before the invasion became uncontrollable. The problem was first examined by the Board of Agriculture which met at Pusa in December 1929 under the auspices of the Council. Several important recommendations were made, but before they could be considered by the Council, information was received early in 1930 that a locust visitation had already commenced. The Committee, slightly enlarged, met at Delhi in February 1930 and before adjourning drew up an interim report making recommendations for the adoption of control measures

which, though they might not completely avoid, might yet reduce the ravages of this pest. The Council took immediate action on such of the recommendations as related to measures of control. With the whole-hearted co-operation of the Governments of the United Provinces and the Punjab which, warned by the experience of visitations in 1929, were already by their own efforts achieving a great measure of success in coping with the visitation of 1930, arrangements were made to have warnings of the visitation of locust swarms transmitted by telegram to the Locust Bureau which the Council established under the charge of a Locust Bureau Entomologist. These warnings were then broadcasted to all the other authorities concerned. From the first it was realised that control measures in British Indian Provinces alone were of little avail unless they were also adopted in the neighbouring Indian States and in those further away which were also victims of this visitation, and in the territories of some of whom locusts were suspected to have permanent or semi-permanent breeding grounds. His Excellency the Viceroy in his speech to the Chamber of Princes in February 1930 made an appeal to the States concerned for co-operation, and the response of the States was prompt and most encouraging. Almost every State concerned took such measures recommended by the Locust Committee as were within its means and the capacity of its revenue organisation, and the services of the Locust Bureau Entomologist of the Council were requisitioned by many States to instruct their officers in control measures. At the first meeting of the Committee the question of locust research could not be touched as the immediate need then was to formulate measures of locust control and take necessary steps to get them as widely adopted as possible, but at its meeting in May 1930 the Committee made far-reaching recommendations in regard to locust research.

Out of a total cultivated area of 260 million acres in India and Burma, there are about 82 million acres under rice. In the circumstances it was only in the fitness of things that the Council should, during this early period of its existence, pay attention to the needs of this crop. In the rice-growing provinces, especially in Madras and in Bengal, a good deal of work was being done but

there was scope for much more. At the meeting in June 1930 proposals from Assam, Bengal, Bihar and Orissa, Burma, the Central Provinces and Madras were considered by a Rice Sub-Committee of the Board and a scheme from the United Provinces was subsequently added and worked into the co-ordinated scheme. The total cost of these schemes, after they had been subjected to scrutiny by the Advisory Board, came to about Rs. 11,22,400. The Board also accepted the recommendation of the Rice Sub-Committee that the Empire Marketing Board should be invited to make a grant of half this amount. In the July meeting of the Governing Body of the Council, at which this group of schemes came up for sanction, it was decided to accept in principle the recommendations of the Advisory Board. Before, however, sanctioning detailed estimates of any individual scheme, the Governing Body desired that enquiries be made from the Empire Marketing Board as to what contribution the Board was prepared to make towards these schemes. Just before the close of the period under review intimation was received from the Empire Marketing Board offering to contribute a sum of Rs. 2,03,279, being half the cost of the Burma and Bengal schemes. The Council is therefore faced with finding a total sum of Rs. 9,19,129, but in view of the importance of rice to India, it is not unlikely that the Governing Body, which has to meet in 1931-32, may choose to find the rest of the money without calling upon the provinces to share in this expenditure.

The investigation of problems relating to the conservation of indigenous manurial resources and the development of the use of indigenous fertilizers have for some years past attracted a great deal of notice in India. They are by themselves of great inherent importance in a country like India where holdings are generally small and the capacity of the agriculturist to buy manures limited. The Council therefore appointed a Fertilizers Committee, which held its first meeting in June 1930. This meeting was an exploratory one and, apart from the recommendations made, the discussion of manurial problems by those interested was of value for the future work of the Committee. Almost every member of the

Committee undertook before the next meeting to investigate and report on some point which had emerged during the discussion. It was felt that, before it could profitably meet again, the existing data on manurial experiments carried out in the provinces in the past should be correlated and made available. For this purpose the Council sanctioned a small grant to each province but it will take some little time before existing data in regard to manurial experiments conducted in the past have been collected and correlated.

The avowed object of the Council is to enlist non-official as well as official agencies in the furtherance of agricultural research. Amongst the former the universities are the most important. Soon after the inauguration of the Council, it was made known to universities that the Council would welcome any proposals for the conduct of research bearing on agriculture in the universities. As a result two applications for grants from workers in the universities of Dacca and the Punjab were sanctioned at the very first meeting of the Council. Since then several other applications have been received and sympathetically considered during the period under review. On its Advisory Board the Council has four representatives of the universities elected by the Inter-University Board. The Provincial Research Committees, which are the provincial counterparts of the Advisory Board, have also representatives of universities on them. The collaboration of workers in the universities on committees appointed by the Council and in the journals published by it, of which mention will be made later, has been sought and is being freely given. In fact, one of the most encouraging signs in the work of the Council is the increasing co-operation which it is receiving from the Indian universities. Numbers of gentlemen unconnected with any of the departments of government have during the period under review helped the Council in an honorary capacity by serving on its committees and by contributing to its journals, and the Provincial Governments in a time of financial stringency and depleted staffs have never refused to let the Council have the benefit of the services of their officers.

Animal husbandry research which should, from its importance to a country like India where animal power is still predominantly used in the practices of agriculture, claim an equal share in the Council's activities did not do so during the period under review. For the reason for this we must go back a little. The veterinary departments in India were not as strong as the agricultural departments successfully to weather the lean financial years which followed the termination of the war. The result was that, when the Imperial Council of Agricultural Research was established towards the end of 1929, the departments concerned with animal husbandry in India were not in such a favourable position to take advantage of the financial facilities offered by the Council because they lacked co-ordination and were undermanned and immersed in the conduct of routine administration. The Imperial Institute of Veterinary Research at Muktesar suffered from a like disability, though more research than could have been reasonably expected from the very restricted and insufficiently organised staff that was available was conducted at that institution. In these circumstances it was hardly a matter for wonder that departments dealing with animal husbandry in India were not at first in a position to share with agricultural departments and the universities in the grants which flowed from the Council. At the close of the period under review this situation had considerably changed for the better. It is not too much to say that the generosity with which the Council financed schemes of agricultural research acted as a spur and an encouragement to the veterinary departments in India, and it is anticipated that progress will be more rapid as the inadequacy of the provision which has been made for animal husbandry work in the past is more fully realized. In April 1930 the animal husbandry colleague of the Agricultural Expert Adviser to the Council reached India and immediately applied himself to the task of finding out what was required to bring animal husbandry research up to a standard and extent commensurate with its value to the country. During the period under review two schemes for the appointment of research officers at the Imperial Institute of Veterinary Research, Muktesar, were sanctioned in

principle. In addition, several other far-reaching schemes were under preparation which, it is hoped, will come to fruition during the year 1931-32. The animal husbandry side of the Council's activities will, however, always lag behind the agricultural until two disadvantages from which it suffers are remedied. One is that the veterinary departments in India are greatly undermanned. Unless these departments are adequately staffed, both in regard to numbers and in the quality of their personnel, it is to be expected that suggestions for conducting research from the provinces will be few and far between. The Council is, however, doing what it can to remedy this state of affairs and it is likely that, as has been stated above, schemes for research in animal husbandry which have been under preparation during the period under review and which entail the giving of grants for the creation of disease investigation staffs in the provinces will come into effect in 1931-32. The Council's resources are, however, not so extensive, nor indeed is it its function to bring veterinary departments in India up to strength, and it is to be hoped that provinces will on their part do what they can within the limit of their means to make up this deficiency. The second disadvantage is that the existing veterinary colleges have been compelled by circumstances to accept comparatively low standards of educational and scientific training for their graduates, while facilities for animal husbandry research, which should be an important part of veterinary education, have been very inadequate at most of these colleges in the past. Requests for grants for schemes of research with an agricultural bias are coming to the Council in an ever-increasing stream from the universities but that is not so on the animal husbandry side ; and in view of the long periods of time required to carry out genetical research in large, slow-breeding animals, and the heavy capital expenditure involved in establishing the comparatively large farms that are required to carry on such research on an adequate scale, it is difficult to see how universities could take up schemes which could be expected to produce results of any practical significance within the term usually set by the Council in making grants. From its very nature, there are only certain lines of animal

husbandry research which can be successfully conducted in the universities.

The Council has, during the period under review, developed its activities in the matter of dissemination of information in three directions, by providing facilities to scientific workers in India to attend Imperial and International Conferences bearing on agriculture and animal husbandry, by subscribing to Imperial and International Institutions which purvey information of value to workers in India, and by means of its three regular publications: the "Agriculture and Live-stock in India", which took the place of both the 'Agricultural Journal of India' and the 'Journal of the Central Bureau for Animal Husbandry and Dairying,' the "Indian Journal of Agricultural Science" and the "Indian Journal of Veterinary Science and Animal Husbandry." In a case where either owing to the length of the article or for other reasons publication in a special form is desired the Council publishes the work in the form of a monograph. All these publications are run on a co-operative basis. The Council has also been made responsible for the preparation and issue of the Review of Agricultural Operations which previously used to be issued by the Agricultural Adviser to the Government of India.

CHAPTER II

ECONOMIC WORK ON CROPS.

The activities of the agricultural departments are now a vital part of the agricultural life of the country and so multifarious are they that in a review like this no more is possible than to draw attention to their more conspicuous features. In this chapter reference will be made to research and development work which can most conveniently be grouped under individual crops. Varietal improvement was the first big success and this provided a useful means for securing other agricultural improvements. Once it was demonstrated that the improved varieties of, for example, wheat and sugarcane would respond to and pay for better cultivation and manuring, the way was open to a general advance towards a higher standard of farming. All improved varieties call for a better standard of cultivation if their possibilities are to be realised in full. Most will give better results than the mixtures they have replaced even without improved cultivation, while a few, especially sugarcane, demand better cultivation as a condition to success. The replacement of inferior by better varieties of crops continues to be one of the most successful lines of work. It makes the least call on the cultivators' scanty capital and is easy to demonstrate as the results are usually obvious.

The ascertained area under improved varieties of crops in 1929-30 was approximately 12·2 million acres and in 1930-31 13·5 million acres, as compared to 12 million acres in 1928-29 and 10 million acres in 1927-28. As will be seen from the data presented for individual crops, these figures by no means represent the whole extent to which improved strains have replaced older varieties. It is almost an impossible task to gauge the natural spread of a variety once it becomes popular and in several important instances it is only possible to give figures for the areas of crops produced from seed distributed by, or with the knowledge of, the provincial agricultural department. The following tables give the present position so far as it can be ascertained.

TABLE I.

Areas under improved crops in India in 1929-31 (in acres).

Province or State.	RICE		COTTON		WHEAT		JUTE		SUGARCANE		OTHER CROPS		REMARKS
	1929-30	1930-31	1929-30	1930-31	1929-30	1930-31	1929-30	1930-31	1929-30	1930-31	1929-30	1930-31	
British India.													
Madras . .	245,326	292,478	260,187	300,572	..	..	..	..	5,321	21,321	36,965	94,526	
Bombay: Presidency Proper.*	1,528	3,447	398,321	410,296	285	11,259	..	..	198	142	3,654	8,983	* Area under departmental seed only.
Sind . .	2,353	2,890	66,005	90,023	84,321	86,052	..	..	..	..	339	410	
Bengal. . .	192,885	223,233	..	..	..	..	1,176,352	1,041,502	74,305	100,000	3,699	17,816	
United Provinces .	..	..	220,000	255,000	1,600,000	1,800,000	..	..	515,000	678,000	213,000	244,000	
Punjab . .	..	..	1,391,200	1,450,200	2,516,600	2,448,000	..	..	80,000	104,400	..	..	
Burma. . .	382,972	436,804	5,002	9,390	..	..	..	..	1,731	250	144,706	166,256	
Bihar and Orissa .	23,057	15,134	..	..	8,462	23,206	104	175	81,664	102,118	3,837	4,866	
Central Provinces .	220,976	254,781	660,199	683,695	355,057	377,372	..	..	1,350	4,269	267,185	306,456	
Assam . .	16,826	18,950	..	..	..	..	63,206	63,320	6,317	7,043	13,134	13,275	
N.-W. F. P. . .	..	..	..	..	330,000	280,000	..	..	1,000	40,500	41,000	41,000†	† Previous year's figures repeated as no estimate was supplied.
TOTAL FOR BRITISH INDIA.	1,085,923	1,247,717	3,000,914	3,199,176	4,894,725	5,025,889	1,239,662	1,104,997	766,886	1,058,043	727,519	897,588	
Indian States (so far as information is available).													
Mysore . .	30,908	38,159	16,972	23,163	..	..	..	..	3,621	6,413	257,403	252,668	
Hyderabad . .	..	..	82,800	114,100	..	..	..	..	..	26	91	340	
Baroda . .	8,120	161	85,054	6,897	1,061	35	..	..	..	..	..	..	
Travancore . .	1,100	1,261	..	..	..	..	..	..	..	..	..	..	
Gwalior . .	..	..	2,500	..	500	..	..	..	..	..	4,000	..	
Patiala . .	..	..	..	165,000	..	356,750	..	..	..	..	..	..	
TOTAL FOR INDIAN STATES.	40,128	39,581	187,326	309,160	1,561	356,785	..	..	3,621	6,439	261,494	253,008	
GRAND TOTAL FOR BRITISH INDIA AND INDIAN STATES.	1,126,051	1,287,298	3,188,240	3,508,336	4,896,286	5,382,674	1,239,662	1,104,997	770,507	1,064,482	989,013	1,150,596	

TABLE II.

*Areas under improved crops in India (in acres).**

Crop	In British India			In Indian States (so far as known)			Total		
	1928-29	1929-30	1930-31	1928-29	1929-30	1930-31	1928-29	1929-30	1930-31
Cotton	3,836,052	3,000,914	3,199,176	127,939	187,326	309,160	3,963,991	3,188,240	3,508,336
Wheat	4,124,829	4,894,725	5,025,889	2,086	1,561	356,785	4,126,915	4,896,286	5,382,674
Rice	956,225	1,085,923	1,247,717	20,688	40,128	39,581	976,913	1,126,051	1,287,298
Jute	1,143,665	1,239,662	1,104,997	..	..	..	1,143,665	1,239,662	1,104,997
Sugarcane	493,592	766,886	1,058,043	6,298	3,621	6,489	499,890	770,507	1,064,482
Groundnuts	519,379	102,490	144,877	7,467	67,685	106,346	526,846	170,175	251,223
Millets †	146,436	164,954	155,447	200,913	193,038	133,666	347,349	357,992	289,113
Gram †	216,116	201,831	222,203	290	..	..	216,406	201,831	222,203
Potatoes †	11,881	13,134	13,275	..	..	..	11,881	13,134	13,275
Other Crops †	361,465	245,110	361,786	581	771	12,996	362,046	245,881	374,782
TOTAL	11,809,640	11,715,629	12,533,410	366,262	494,130	964,973	12,175,902	12,209,759	13,498,383

* In several important instances figures have only been supplied for areas under departmental seed, no estimate of natural spread being given.
† Not separately reported by some Provinces.

COTTON. The apparent reduction in 1929-30 is mainly due to a change in the method of reporting in Bombay which makes a reduction of some 600,000 acres of which only about 20,000 represent a real difference. In 1928-29 that Presidency had 1,036,873 acres under improved cottons of which 426,402 acres were grown from departmental seed and 610,471 acres represented the estimated natural spread. In 1929-30, the area reported as grown from departmental seed was 398,321 acres and in 1930-31 410,296 acres but no estimate of natural spread was given.

RICE. The large increase in areas under improved strains is mainly in Burma, Madras and Bengal.

JUTE. The area under improved varieties is practically stationary despite a large decrease in the total jute area.

SUGARCANE. The large increase has taken place in the United Provinces, the principal sugarcane province, and the area under improved canes was ascertained by special enquiry.

GROUNDNUTS. The apparent reduction is due to a change in the method of reporting in Bombay.

1. Rice.

On an average this crop occupies about thirty-five per cent. of the total cultivated area in India, and the following table shows the area and yield during recent years :—

—	1927-28	1928-29	1929-30	1930-31	Average for the quinquennium ending 1930-31
Area in acres . .	78,470,000	83,275,000	80,622,000	82,428,000	80,898,000
TOTAL PRODUCTION IN TONS OF PADDY.	28,234,000	32,145,000	31,132,000	32,034,000	30,645,000

Both the area and the yield of the rice crop are considerably affected by the monsoon; the proportion of the rice area irrigated from canal and other sources varies considerably in the different provinces. The rice crop of 1929-30 was good on the whole; the reduction in area occurred mainly in Bengal, Assam and Hyderabad. The crop of 1930-31 approximated to that of 1928-29 both in area and yield, and the yield was generally satisfactory, but exports of rice and paddy during 1929-30 and 1930-31 amounted to 2,326,000 tons (7·5 per cent. of the total production) and 2,279,000 tons (7·2 per cent. of the total production), respectively, as compared to 1,816,000 tons (5·6 per cent. of total production) in 1928-29. These exports consisted almost entirely of rice 'not in the husk' which accounted for 2,298,000 and 2,254,000 tons, respectively. Of the exports, Burma accounted for 88 per cent. in each of the two years, Bengal for 5 per cent. and Madras for 4 per cent. in 1929-30 and 5 per cent. in 1930-31. Exports of Burma rice to India amounted to 1,254,000 tons in 1928-29, 1,089,000 tons in 1929-30 and 989,000 tons in 1930-31. In March 1931 the export duty on rice was reduced by one-quarter, *viz.*, from 3 annas to 2 annas 9 pies per maund. An interesting feature of the export trade was the increase in exports to the United Kingdom from 35 000 tons in 1928-29 to 79,000 tons in 1929-30 and 114,000 tons in 1930-31;

this was largely due to propaganda carried on in Great Britain by the High Commissioner for India and the Empire Marketing Board.

Reference has been made in Chapter I to the scheme of research work on Indian rices which the Imperial Council of Agricultural Research, with the financial assistance of the Empire Marketing Board and the co-operation of the principal rice-growing provinces, has been able to inaugurate. Some of the staff for the various sections of the scheme have recently been appointed and the rest is now being recruited. Though work under this scheme falls outside the period under review, the general outlines are sufficiently important to be indicated here. Briefly, this is an attempt to co-ordinate rice research in India by providing better means for co-operation between different workers and by the provision of funds and scientific staff to undertake sections of the work which had received insufficient attention. The provinces included in the scheme are Madras, Bengal, United Provinces, Burma, Bihar and Orissa, the Central Provinces and Assam, representing in 1930-31, 93 per cent. of the total area under rice in India. In all provinces a good deal of work has been done already, some of it of broad scientific value and of much more than provincial importance, so that the present scheme aims at supplementing existing work, filling gaps and promoting the better interchange of information and material between provinces. Though the agency is provincial, the scheme is essentially of an all-India character. Important conditions attached to the grants made by the Imperial Council of Agricultural Research on this scheme are : (i) that there should be a free interchange of selected types between experimental stations and farms of adjacent tracts in different provinces, (ii) that the fullest facilities should be given to economic botanists and others working on paddy to meet each other from time to time at the various research stations, (iii) that at each research station or sub-station all definite unit species, which are isolated in the course of plant-breeding work, should be fully described, maintained and made available to workers in other parts of India, (iv) that in addition to the actual production of improved strains, each station should devote attention to the general genetics of the rice plant and to the

clearing up of obscure points in connection with the inheritance of characters, (v) that in several provinces, where the agricultural and botanical surveys of the varieties of rice are unfinished, these surveys will be completed, and (vi) that experimental work will not be confined to botanical investigations but in each province adequate attention will be given to field experiments and to the cultural and manurial aspects of the problem. With reference to the last condition, it may be remarked also that special attention is devoted to the biochemical aspect at the Central Provinces research station. Further, the Imperial Council of Agricultural Research is also separately giving financial aid to investigations in the nutrition of the rice plant at Dacca University in Bengal and the Royal Institute of Science, Bombay.

Brief mention may be made of the principal features of the various provincial sections of the scheme. In MADRAS, the successful work at the Coimbatore Paddy Research Station has already solved some of the more important problems connected with paddy cultivation in Madras. A sub-station in Ganjam district to cater for the work in Madras and Orissa is provided.

In BENGAL, the improvement of the rice crop has been the principal work of the Economic Botanist for some 22 years and a great deal has already been done. Two important types of rice, however, have not yet been adequately studied, the fine Patnoi or Patnahi rice, grown mainly in the Twenty-Four-Parganas and Sundarbans district, which constitute the Patna rice of commerce, and the rices of Western Bengal. Provision has been made for two sub-stations, each under a research officer, for the study of these rices.

In the UNITED PROVINCES, a botanical and agricultural survey of the rices of the province leading on to a preliminary classification had already been made by the Economic Botanist and some work on the development of the root-system of the rice plant had been published. A new station in Rohilkhand under the control of the Economic Botanist, United Provinces, has been provided for, where plant-breeding and physiological work will be undertaken as also cultural and manurial experiments. The immediate object will

be the production of a higher-yielding and better quality rice for the area which has recently come under irrigation from the Sarda Canal.

The BURMA portion of the scheme is of special interest in that Burma provides the bulk of the rice exported from India and also supplies an average of about one million tons annually to the rest of India. The scheme provides especially for an intensification of plant-breeding work directed to the improvement of the quality of the indigenous rices without loss of yield. Questions of preparation and marketing will receive early attention. A special paddy research station is being opened and specialists with a research staff are to be engaged.

In BIHAR AND ORISSA, the second of the rice-growing provinces in point of area, a number of quite distinct rice tracts exist, each possessing its own characteristic varieties, soils and problems. The scheme, therefore, includes a rice specialist working at a central station with a number of sub-stations in the other rice tracts. Work has already started on the scheme and includes the completion of the rice survey, the isolation and testing of pure strains, and further work on manurial and cultural requirements.

In the CENTRAL PROVINCES, a preliminary survey of the rices has already been made and heavy-yielding types brought under cultivation and some preliminary work has been carried out on the cultural and manurial requirements of the crop and on the various soils of the Central Provinces. An existing experimental farm in the principal rice tract is being raised to the status of a research station and a biochemist and a botanist with the necessary staff of assistants engaged. In this way both the varietal and environmental aspects of the problem will receive adequate attention.

In ASSAM a special study will be made of the "deep-water" varieties of rice which are of great economic importance both in that province, in Eastern Bengal and in Orissa.

Current work in the Provinces.—During the two years under review, the paddy-grower in rice provinces has felt acutely the fall in prices. In many places it is necessary to go back 30 years

or more before a parallel can be found to the low prices of 1931. As is often the case in such slump periods, the actual prices obtained by growers were even lower than market quotations would indicate. Hence all means for making paddy cultivation more efficient and thus reducing the cost of production are of unusual importance.

From 976,913 acres in 1928-29 the total area under improved varieties had risen to 1,126,051 acres in 1929-30 and 1,287,298 acres in 1930-31.

MADRAS. This Presidency has about 13·8 per cent. of the total area under rice in India and produces about 16·9 per cent. of the total Indian crop—

—	1928-29	1929-30	1930-31
Area in acres	11,019,000	11,262,000	11,678,000
Production of paddy in tons . . .	5,197,000	5,255,000	5,376,000

A feature of the crop in Madras is the high percentage (73) of the crop which is irrigated; the irrigated rice crop accounts for about 84 per cent. of the total irrigated area. This is an unfavourable factor with present low prices.

The area under improved rices increased from 215,931 acres in 1928-29 to 245,326 acres in 1929-30 and 292,478 acres in 1930-31. Eight strains, *viz.*, G. E. B. 24, Co. 1, Co. 2, Co. 3, Co. 4, Co. 5, Co. 6 and Co. 7, all of proved superiority, have been issued from the main rice-research station at Coimbatore and are all in keen demand. The strain G. E. B. 24 is of special interest because of its suitability to very varying conditions. In Bellary, for example, it has replaced the local rices to the extent of 60 per cent. in two taluqas. In other circles, its resistance to the stem-borer makes it valuable. A number of Tinnevelly varieties of rice have been under study for some years and promising strains have now been released for district testing. At the three sub-stations of Aduturai (Tanjore and Trichinopoly districts), Maruteru (Godaveri and Kistna districts) and Pattambi (Malabar and South Kanara districts) the main consideration is the raising of pure-line seed, and marked success has been obtained by the isolation of the best types from

local mixtures. Both at Coimbatore and the sub-stations, attention has been paid to a number of practical problems in rice cultivation and manuring. In view of the fall in paddy prices and the extreme probability of local over-production of paddy in Madras, the question of profitable crops such as sugarcane, groundnut and plantains which might be grown in rotation with paddy, has been taken up. In such rotations, the choice of the most suitable variety of paddy may be of great importance. Green-leaf manuring still gives the best and the most profitable result, but a small deficit of green leaf can be made up for by the use of an equivalent quantity of nitrogen supplied as sodium nitrate. From the Aduturai Station nine types have already been released and despite all efforts to keep pace with it, the demand still outstrips the supply. Other strains are under test. At the Pattambi Station, quite a large number of strains are in various stages of trial. Several have given marked increases over the unselected material; the strains Co. 3, Co. 5 and Aduturai 2 have shown promise here. At the Maruteru Station no selected strain was yet ready for issue but as in previous years mass-selected bulk seed of local varieties was in demand. Several of the strains under test show great promise. The Coimbatore strain G. E. B. 24 has proved more resistant to stem-borers than local varieties.

The research work at Coimbatore included work directed to the production of types resistant to the ' blast ' disease and the inheritance studies of several characters of economic importance. The heredity of the length of the panicle has been worked out, that of grain length is under study and also that of leaf-size. Other inheritance studies are also in progress. It has been found that the tendency to lodge and its converse are associated with two types of growth habit of the tillers. It has also been found that, though very much subject to the influence of environmental conditions, the tillering habit of a rice plant is a Mendelian character and that the inheritance can be traced out by reducing modifying influences to a minimum.

Special attention has been given to the organisation of the supply of seed of improved strains. Details are not available for all circles

but even so, 2,128 tons of seed in 1929-30 and 1,232 tons of seed in 1930-31 were issued through or by arrangement with the Department; these figures include supplies by co-operative seed farms and by individual seed-growers. Most success has been obtained by the organisation of private seed-farms under departmental supervision: an effort is made to render each area self-supporting in regard to the seed-supply of a new variety as early as possible.

In BOMBAY PRESIDENCY, the rice crop is only locally important, the average area and production being $3\frac{1}{2}$ million acres and $1\frac{1}{2}$ million tons, respectively. Since the Agricultural Departments in Bombay and Sind are now independent, work in Sind is separately discussed and what follows relates to the Presidency proper. The area and production for the past three years are shown below:—

—	1928-29	1929-30	1930-31
Area under rice Bombay Presidency proper in acres.	1,953,394	1,928,252	2,264,000
Production in tons	937,813	813,797	989,000

Research work on rice is mainly concentrated at the Karjat Rice Station, with sub-stations for local work at Ratnagiri, Kumta in Kanara district and Mugad in Dharwar district. Breeding work has mainly consisted of the selection of pure-line strains from the local varieties and the subsequent testing and multiplication of the most promising. A number of promising strains have thus been obtained suitable for the diverse conditions of the Konkan districts. During the past two years particular attention has been paid to adequately replicated yield tests. The scheme for the multiplication and supply of seed of improved strains of rice generally resembles that adopted so successfully for cotton. Seed from the departmental farms is issued to registered seed-growers (97 in 1929) for multiplication and their fields are inspected and "rogued" by departmental staff. The produce from seed-growers' fields is distributed through the taluqa development associations, seed societies, grain banks and trade agencies. The supervised seed production area was about 400 acres in 1929 and 710 acres in 1930.

In this way the Department is able to control pure seed for about 15,000 acres annually.

Manurial and cultural experiments have also been carried out. In the Kumta tract green manuring *plus* bonemeal has given successful results, as has the addition of ammophos (at 100 lbs. per acre) to the basic dressing of farm manure; calcium cyanamide has also given good results. At Karjat sulphate of ammonia continues to be profitable: the effect of continued applications on the organic matter and lime content of the soil is being studied, the preliminary result being that on the trap soils both tend to be depleted.

SIND. During recent years the area under rice in Sind has been approximately 1,180,000 acres with an annual production of about 506,650 tons. Breeding work is carried out on the Larkana Farm, and three selected strains Kangni 27, Jajai 77 and Prong 36 have been established. A seed multiplication scheme has been worked out. Many well-known varieties from Bombay and other provinces have been under observation but many appeared to possess too long a vegetative period. Ratnagiri 61, Dehra Dun Bansmati, Peshawar Bara and an acclimatised Bengal variety, now known as Bengalo, showed promise.

Hybridisation between Kangni 27 and the Karjat strain Kolamba 184 promised well, as the F_2 generation included some heavy-yielding types. The area under improved varieties was 2,353 acres in 1929-30 and 2,890 in 1930-31.

BENGAL. On the average of the last three years rice occupied 20·7 million acres in Bengal or 25·2 per cent. of the total area in India, and production is estimated at 9 million tons or 29 per cent. of the total for India.

The 1929-30 crop was somewhat below that of 1928-29 in area (20,225,000 acres as compared to 21,403,000 acres) and the yield of 8,202,000 tons, as compared to 9,684,000 tons in 1928-29 and an average of 7,892,200 tons for the five years ending 1928-29, was mediocre. In 1930-31, the area increased slightly to 20,582,000 acres and the yield (9,206,000 tons) was satisfactory. The ascertained area under improved varieties increased from 185,255 acres in 1928-

29 to 192,885 acres in 1929-30 and 223,233 acres in 1930-31. There were in 1929-30, 247 private local paddy seed-farms for the multiplication of improved strains of paddy and 240 in 1930-31. These seed-farms covering 1,200 acres provided 13,000 maunds of seed in 1930-31, of which only 1,787 maunds came from Government farms.

Research work was carried out at four centres, *viz.*, Dacca for Eastern Bengal, Chinsurah for Central and Western Bengal, Barisal for the " Balam " tract and Bankura and Suri for Western Bengal. In addition, varietal tests of selected strains were carried out at most of the district farms of the province.

In Eastern Bengal, Indrasail and Latisail continue to stand first, and careful yield trials spread over four years gave 25 per cent. more than the best local variety. Bhasamanik, a new type from Chinsurah, has done well and the hybrid C. 22×R. 22 is one of the heaviest of the early types, but the cross D×I (13) is better if quality be taken into consideration.

Eight years' results of varietal tests at Chinsurah of selected *aman* strains have given the following average results, taking unselected local Nagra as a standard: Bhasamanik 34·92 maunds per acre, Dudsar 33·97 maunds, Jhingasail 33·77 maunds, Nagra No. 68 33·70 maunds and Nagra local 29·97 maunds. Dudsar is recommended in Western Bengal instead of Indrasail, as being slightly earlier and more drought-resistant. Bhasamanik is a new strain, closely resembling Nagra. It was selected from a mixed sample of local Bhasamanik seed, collected from Hooghly district 12 years ago. In the varietal tests at Chinsurah, it has stood first five years out of eight, and has established its right to be considered the heaviest-yielding of Western Bengal selections. It is now being distributed. Jhingasail is also doing well, and a considerable demand for this paddy is springing up in Bankura district. Among *aus* selections at Chinsurah, Jhanji, a strain from Bankura, and among early *aman* selections a cross D×1 (13), from Dacca, are promising. The last mentioned hybrid, which has been selected from

a cross between a strain of Daudkhani and Indrasail, has yielded more than local Nagra in the varietal tests for four consecutive years and ripens a week earlier. Work has also been commenced on the improvement of Patnai paddy of commerce, grown mainly in the Sundarbans of the 24-Parganas and Khulna, but also in Hooghly and Howrah districts. This paddy is the chief paddy milled in Calcutta mills for foreign export. In recent years the export has declined considerably and complaints are being made of deterioration both in yield and quality. Collections from all over the areas where this paddy is grown have already been made and preliminary experiments started during 1930. In connection with this work and with work on rice in Western Bengal generally, Sir Hari Sanker Pal has very generously given a donation to the Department of Rs. 7,000 for a field laboratory. At Barisal several improved strains of the local Balam rice and other salt-resistant varieties were distributed. Strains of Patnai rice are promising to be heavier yielding than the Balams. At Rajshahi and throughout the Barind tract of Northern Bengal the paddy crop was badly damaged by a fungus disease *Sclerotium oryzae*. Only early varieties were affected. In the varietal tests on the Rajshahi Farm it was noted that the departmental varieties were free from the disease and yielded a normal crop, while the local variety was badly affected and yielded a very poor crop. The average figures of yield too bear this out. The departmental selection Dudsar, which stood first, yielded 20 maunds 24 seers per acre (average of six plots), while local Gazia yielded only 5 maunds. Such was the case wherever the disease occurred and, as a consequence, a considerable demand arose for departmental seed. The Department of Agriculture, collaborating with the Collector, brought into the tract nearly 6,000 maunds of departmental seed, which was immediately taken up by cultivators, partly by purchase and partly on loan. The collection of so large a quantity (a train load) was greatly simplified by the knowledge of where successful seed farms had resulted in large scale cultivation of departmental paddy.

Heavy dressing of lime to the acid soils of Dacca produced increased yields, but due to constant washing and inundation in

these soils, the lime did not seem to be retained in sufficient amount to keep up this effect.

On the average of the last three years, rice occupied 14·2 million acres in BIHAR AND ORISSA, or 17 per cent. of the total area in India. The 1929-30 crop was a little below that of 1928-29 in area (14,229,000 acres as compared to 14,352,000 acres) but the yield of 6,011,000 tons was considerably above that of the latter, *viz.*, 5,558,000 tons. In 1930-31 the area decreased slightly to 13,927,000 acres and the yield of 5,615,000 tons was satisfactory. The area under improved varieties was estimated to be 20,250 acres in 1928-29 and 23,050 acres in 1929-30, but the estimate in 1930-31 was only 15,134 acres. There has been a marked fall from 10,494 acres in 1929-30 to 756 acres in 1930-31 in the area under improved Dahia rice in South-East Bihar, where at one time this rice covered 50,000 acres. The cultivators' complaints of short weak straw and damage to the crop by heavy October rain may not be wholly without foundation, but the real cause of the reduction in area appears to be more a lack of effort to keep the seed pure, with the result that now it is little different from the local Dahia rice. Steps, however, have been taken during the last two years to encourage cultivators to obtain pure seed from the various departmental farms. The problem of improving strains of rice in this province is particularly difficult as the various rices are not grown in homogeneous areas as in Bengal. In Chota Nagpur, in the same village may be found dry rice, early rices in the high terraces and lower down medium rice, while the main crop rice is in the lowest land where there is the best water-supply. Dahia is a medium season paddy of fairly good quality and is spreading all over the province. In Chota Nagpur the variety known as Rais is recommended for the early terraces, Kankesal and Dahia for lower terraces and Latisail for the lowest land. Dahia has been found useful in South Bihar and in South-East Bihar. For Orissa there are four Cuttack selections which have given good results. Two years' trials at Cuttack tend to show that almost any early *aman* paddy may be grown. Dahia and Cuttack No. 1 have been found to be suitable on the low-lying tracts that are submerged until late in the season.

As the seed of these two varieties is available in sufficient amounts, a great difficulty which used to be experienced during years of heavy flood has been removed.

All farms were conducting experiments on artificial and natural manures and great differences were found in the manurial requirements of the various parts of the province. Niciphos, ammophos and ammonium sulphate, *dhaincha* with superphosphate, fish manure and farmyard manure all have their place. This province is well in the van with regard to the use of artificial manures and importing firms have established complete organisations for the distribution of the commoner forms, but the fall in price during the last two years has now greatly restricted their use.

On the average of the last three years, rice occupied 12·8 million acres in BURMA or 15·6 per cent. of the total Indian acreage and the production was estimated at almost five million tons or 15·7 per cent. of the total Indian output. The area gradually increased during the last three years from 12,709,000 acres in 1928-29 to 12,861,000 acres in 1929-30 and 12,911,000 acres in 1930-31 and the yield increased in proportion from 4,894,000 tons to 4,986,000 tons and 5,073,000 tons, in the respective years. The area under improved rices increased from 323,125 acres in 1928-29 to 382,972 acres in 1929-30 and 436,804 acres in 1930-31. Apart from the major seed-farms worked by the department, grazing ground seed-farms were leased to cultivators for the multiplication of seed. During 1929-30 there were 92 of these seed-farms, comprising an area of 5,440 acres, and in 1930-31 107, covering an area of 6,570 acres. The total amount of seed distributed from both sources was 2,827 tons in 1929-30 and 3,961 tons in 1930-31. Particular attention has been given in Burma to the improvement of the rice crop and to the distribution of strains which will meet the requirements of the export trade. That this work is progressing along right lines is indicated by the favourable reports received from the Burma Chamber of Commerce on samples submitted for commercial opinion. In 1929-30 two strains from Akyab farm and six from Mudon farm were considered to be suitable for export to all markets. Attempts were also made to see whether the high grade type of rice

known as Emata could be substituted for the Ngasein and Letywezin types with a view to enabling Burma rice to find an entry into high quality markets which are now barred to it. Trials with this type of paddy, the cultivation of which was formerly confined to the Prome district, have been made in the Irrawaddy, Southern, Tenasserim and East Central circles but the reports received do not make it clear that it is proved as yet that the department can with safety recommend the substitution of this type for the previously grown Ngaseins and Letywezins. It is obvious, therefore, that caution will have to be exercised before any distribution policy on a large scale is decided on. In the meantime the staff at Hmawbi are busily engaged in getting better types of Ematas and samples of two of these have been submitted to the Trade Commissioner for India for evaluation by the experts of the Empire Marketing Board who will express an opinion on their suitability for the European market. The position of the trade in Arakan was so serious as to engage the attention of Government some three years ago. The department has now been able to get into stride in this division, concentrating its efforts mainly in the Akyab district which produces the bulk of the export paddy of Arakan. In the year 1928-29 the seed distributed amounted to six tons, increased to 72 tons in 1929-30 and to 120 tons in 1930-31, whilst it is estimated that 150 tons of departmental seed were distributed by the cultivators themselves with the result that the general quality of this year's crop showed a marked improvement. The problem, however, in Arakan is of much simpler solution than it is in the larger areas of the Irrawaddy and Pegu divisions.

Work on the improvement of the rice varieties of the province was continued at Hmawbi, Myaungmya, Akyab, Mudon and Mandalay. A considerable amount of attention was given at Hmawbi to the improvement of the Emata type as already mentioned, and to the production of varieties suitable for flooded conditions. Work at Mandalay dealt with the improvement of Upper Burma rices. A re-classification of varieties of rices in the province was undertaken. Nine new selections of Ngasein made in 1929 were tested for yield against Mandalay Ngasein C. 2104,

a variety now under distribution. Several have given higher yields and one C. 2991 was decidedly superior to all the rest. Attention was also paid to varieties of Kalagyi and Mweswai.

Work with fertilizers was carried on at all the stations, but the recent excessive fall in the price of rice has practically cancelled the profits derived from their use. The price of paddy has fallen about 50 per cent. in the last two years while the price of fertilizers has fallen only 8 per cent. In the circumstances, they cannot now be recommended to cultivators with the same certainty as in previous years. The experimental work was nevertheless continued with interesting and useful results. These are not identical at all stations. The Myaungmya station reports that the paddy soil of that area responds readily to bonemeal which yields a surplus even when the application is as low as half a cwt. per acre. This result has not been obtained at any other station. At Akyab and Mudon, at which places the rainfall is over 200 inches, significant results have not yet been obtained from the use of ammonium phosphate manures, while at Hmawbi and Mandalay increases in grain yield up to 50 per cent. have been obtained. At all stations careful estimations of the residual effect of these fertilizers were kept. Cultivation experiments have been done at some of the stations dealing with the number of transplants per acre, with the comparative advantage of broadcasting and with other matters. The results obtained at Hmawbi on the broadcasting *versus* transplanting experiments appear to indicate that broadcasting gives as good a yield as transplanting, provided fertilizers are used in both cases. The results of the Hmawbi trials indicated that the optimum seed-rate of sowing was 50 lbs. per acre and that the increased yield of 160 lbs. per acre obtained by transplanting did not pay for the cost of the operation and that better yields and return on outlay can be obtained by sowing broadcast at 50 lbs. and fertilizing with an ammonium phosphate fertilizer than by transplanting. Tests have shown that certain manures, notably potassium and ammonium sulphates, either alone or in combination with other manures, cause an increase in breakage during polishing of Ngasein rice. Similar tests on Taungdeikpan manured with diammophos

did not give such definite results; so further data are obviously required to show what effect fertilizers may have on the milling qualities of different varieties of rice.

On the average of the last three years the area under rice in the UNITED PROVINCES is 6·9 million acres or 8 per cent. of the total area of rice in India, and the yield was estimated at 1·4 million tons or 4·5 per cent. of the total Indian production. Several selections of high-yielding rice have been made, of which 265 maunds of pure seed were distributed in 1929-30 and about 300 maunds in 1930-31. The bulk of this went to the Sarda Canal area, the development of which depends on the success of replacing the present coarse broadcast rices by fine varieties. In order to produce a variety which will be immune to the attack of *gundhi* (*Leptoeorisa varicornis*), hybridization has been resorted to using a coarse variety called Sathi which escapes the *gundhi* on account of morphological characters.

In the CENTRAL PROVINCES the area under rice is, on the average of the last 3 years, 6·2 million acres and the yield 1·7 million tons. From 6,199,000 acres in 1928-29 the area fell to 5,854,000 acres in 1929-30 and rose again in 1930-31 to 6,721,000 acres, while the yield rose from 1,647,000 tons to 1,909,000 tons and fell again to 1,664,000 tons in the three corresponding years. The area under improved varieties steadily rose from 182,000 acres in 1928-29 to 225,000 acres in 1929-30 and to 255,000 acres in 1930-31. The actual area under improved strains is much larger than the above areas, which are only the actual areas sown by seed from organised supplies. The number of private seed-farms increased from 2,550 in 1929-30 to 2,850 in 1930-31, and the quantity of seed distributed from them was 4,400 tons and 4,610 tons in the two years. Work on seed selection has resulted in the isolation of nine new strains of some of the well established varieties such as Bhata Gurmatia, Gurmatia, Bhondu, Parewa, Surmatia, Chinoor, Luchai and Dilibuksha and these strains have been proved to be of uniform quality and improved cropping power. A system of classification based on certain botanical characters has been introduced into which all the varieties known to exist in the province can be placed and this will facilitate

further breeding work on this crop. Such work has already yielded important results, as heavy-yielding strains of rice with coloured stems have been obtained which are easily distinguishable from the wild rices. It was formerly difficult for the rice-grower to distinguish in the early stages of growth between wild rice and the cultivated varieties, and this caused him considerable loss. Three definite hybrids combining the desired characters have been fixed and their yields thoroughly tested, with the result that the hybrids were shown to be better yielders than the parent strains. Another prevailing defect in some varieties of rice is the weak character of the straw which causes the crop to fall or lodge, and the problem of eliminating this is receiving attention. In view of the importance of the rice crop to the provinces, much more work is called for, and this will be possible in the future in the scheme of research approved by the Imperial Council of Agricultural Research.

In ASSAM the average area under rice for the last three years was 4·6 million acres or 5·5 per cent. of India's total rice area, and the yield was 1·5 million tons or about 5 per cent. of the total production. In 1929-30 there were unprecedented floods in the Surma Valley and Naugong where the autumn and winter broadcast rice and *sail* seedlings were almost totally destroyed. The area under improved varieties was 12,562 acres in 1928-29, rising to 16,826 in 1929-30 and to 18,950 in 1930-31. In 1929-30, altogether 134 tons of improved seed were distributed in the Surma Valley mainly to replace stocks in the flood-stricken area and 21 tons in the Assam Valley. As a result of work done at the two main experimental farms at Karimganj and Titabar, ten *aus*, ten *sail* and three *asra* varieties have been distributed widely. In the Surma Valley the *aus* variety Dumai 36/44 topped the list with an increase of 1,174 lbs. per acre, while the *asra* variety Sail Badal gave an increase of 869 lbs. per acre in the Surma Valley and 1,260 lbs. in the Lower Assam Valley as compared with the local varieties. At the Titabar farm sodium nitrate, bonemeal and potash as well as farmyard manure and potash gave marked higher yields, while the absence of potash from the two combinations brought down the yields to nearly half.

In MYSORE STATE the area under rice rose from 707,000 acres in 1928-29 to 721,000 acres and then to 764,000 acres in the next two years, while production rose steadily from 204,000 to 210,000 and then to 227,000 tons in the corresponding years. The area under improved varieties rose rapidly from 13,522 acres in 1928-29 to 30,908 in 1929-30 and 38,159 in 1930-31. G. E. B. 24 was the improved variety most generally grown and it continued to extend rapidly in most areas where it has been introduced. Among other varieties whose area was extended are Chintamani Sanna and Banku. Rice-breeding work centred at Nagenhalli has given most promising results. Selections from a number of local varieties have given yields much in excess of that of G. E. B. 24, while some of them have shown as high a percentage of rice to paddy and a better quality than that variety. Seed of the best of these selections was multiplied at Nagenhalli for general trial on ryots' fields during the next monsoon. Preliminary work on Mulnad rices at Marthur indicated that, in the course of one or two years, selections will be ready which will give decidedly higher yields than the varieties now grown. Important experiments on the duty of water for rice under tank irrigation were brought to a close in 1929-30. They had extended over five years and six crops. While they show that the rather wasteful application of water which ordinarily takes place gives a somewhat higher yield, they also show that a very much more economical utilization of water is possible. A supply of water more than double that of the minimum used (65·5 inches of irrigation water *plus* 14·3 inches of rainfall) increased the yield by only 9 per cent., from 1,849 lbs. to 2,032 lbs. of rice in husk. The possibility of a more economic utilization of water in places of limited supply is thus indicated.

In the PUNJAB rice is of comparatively little importance except in the south-west corner. The total area is only some 976,530 acres. A classification of the rices of the area was made and five promising strains were under yield trial.

In TRAVANCORE the area under rice was 669,275 acres of which about 1,300 acres were under improved strains. About 27,000 lbs. of improved seed were distributed annually. Valsiramundan

and Samba were the common improved rices. Jamboli, G. E. B. 24, Co. 2, Puzhuthupiratty and Panamkuruva were the best of the varieties under trial. Groundnut-cake, ammophos, bone compost, and superphosphate were all found suitable. Improved methods of cultivating rice were demonstrated at 55 centres.

In BARODA the variety known as Early Kolam is reported to be increasing in popularity and arrangements have been made to supply seed among reliable cultivators for multiplication.

2. Wheat.

On an average this crop occupies about 10 per cent. of the total area under cultivation in India. The following table shows the area and yield during recent years—

——	1927-28	1928-29	1929-30	1930-31
Area in acres	32,190,000	31,973,000	31,654,000	32,180,000
Total production in tons . . .	7,791,000	8,591,000	10,469,000	9,305,000

The total area under wheat during 1929-30 was 31,654,000 acres, which meant a decrease of one per cent. below that reported in 1928-29. The weather was much better than in the preceding year and the total outturn for 1929-30, in spite of the smaller acreage, was a record one of 10,469,000 tons representing an increase of 20 per cent. compared with the 8,591,000 tons of the preceding year. During 1930-31 the area increased by about 1·7 per cent. to 32,180,000 acres. The season was a good one and the outturn was 9,305,000 tons, being 11 per cent. below the record figure of the previous year. From 4,126,915 acres in 1928-29 the total ascertained area under improved wheats had risen to 4,896,286 acres in 1929-30 and to 5,382,674 acres in 1930-31, representing 17·4 per cent. of the total area under wheat in India. Seventy-eight per cent. of this area under improved wheat is in the Punjab and the United Provinces. Owing to the inadequate crops of the

previous two years, India had to import wheat in order to meet her own requirements. In 1928-29, however, India exported 115,000 tons, mostly at the beginning of the year, when the crop prospects were good. In order to make up for these exports and to meet the deficit caused by the unexpected lower crop, India imported in that year 562,000 tons. The net imports then were 370,000 tons. In 1929-30 exports fell to the negligible figure of 13,000 tons. Further, India had to make up the deficit in her wheat supplies by importing 357,000 tons from abroad. In spite of the bumper crop of ten million tons in 1929-30 and the consequent large exportable surplus, the export demand in 1930-31 did not reach a very big figure though it was much larger than the previous year's very low figure. This was owing to the competition of foreign wheat in international markets. Imports into India during the year amounted to 232,000 tons. Imports on this comparatively large scale in a year when India had a bumper crop available, was a remarkable feature of the trade but it was simply a matter of price. Australian wheat could be placed in the sea port towns of India at lower prices than those which had to be paid for Indian wheat brought long distances by rail from up-country producing areas. A large quantity was imported into Calcutta, Bombay and Rangoon, and it was at last necessary for Government to intervene in order to help the wheat-growers in the country. At first a reduction in railway freight was granted to wheat consignments to Calcutta and Karachi, but as it was feared that this action would not suffice, a further step was taken by levying a duty of Rs. 40 per ton on imports of foreign wheat. This latter action was taken in March 1931, and its effects will be felt in 1931-32 as it was brought into force at the end of the period under review.

During the two years the price of wheat fell steadily with disastrous effect. In the Karachi market prices moved almost in sympathy with those in the international wheat market. In April 1929, the quotation for white wheat per candy of 656 lbs. stood at Rs. 45-8 and, with slight fluctuations, prices were almost continually on the decline till March 1931, when the price was Rs.19. Apart

from a rise in prices the amelioration of the wheat growers' lot can only come through improvement of quality and lowering the cost of production.

PUSA. The new wheats P. 111, P. 112, P. 113 and P. 114 gave high yields both at Pusa and Shahjahanpur. Of the numerous cultures of crosses between Pusa 4 and Federations and between P. 52 and Federations, grown on a field-scale, two—P. 163 of the former and P. 115 of the latter—proved to be the best in 1930-31 and were chosen for further trial. In 1929-30 the attack of rust was moderate on some varieties and was very slight on the selected ones but the weather conditions in the succeeding year were exceptionally favourable for rusts, and this afforded a good opportunity for the study of rust-resisting qualities of the various cultures under study. It is interesting to note that at Pusa orange rust (*P. triticina*) was the most serious of the rust diseases and that the selected varieties were generally resistant to this rust. At the sub-station of Karnal, however, yellow rust (*P. glumarum*) was the most serious rust disease in the year under report and both Pusa 52 and Pusa 115 were badly attacked by it, although neither of these wheats was badly rusted in Pusa. With the object of investigating the quality of some Pusa wheats grown at Pusa under dry conditions, and at Mirpurkhas under irrigation conditions, and to compare with some Sind wheats, 16 samples were sent to England for milling and baking tests. These tests were carried out by the Research Association of British Flour-Millers and a report on the results was published in the *Indian Journal of Agricultural Science*, 1, 1931. In the milling and baking tests carried out by that Association Pusa 111, a new wheat bred at the Imperial Institute of Agricultural Research, Pusa, proved equivalent in value to good Manitoba wheat, and the Association reported that if it could be successfully grown in India, it would be of commercial importance as a strong wheat. Millers need both strong and weak wheats to secure, by mixing or blending, flour of given baking properties, and two of the Pusa samples, *viz.*, the well-known Pusa 12 and Pusa 114 are reported to have high blending value and from all points of view are classed as superior

to the ordinary commercial Karachi wheat used in England for blending.

At Pusa a certain area is set apart for growing pure seed of the best varieties for distribution to departments of agriculture and private growers for renovation of stocks; and, in 1929-30, 419 maunds were distributed and, in 1930-31, 469 maunds, the principal types being P. 4, P. 12, P. 52 and P. 111. A field-trial to test the influence of ammophos on the yield of grain and straw in wheat showed a significant increase of about 10 per cent. on each.

The PUNJAB has about 34 per cent. of the total area under wheat in India and produces 39 per cent. of the total crop. In 1928-29 the area under wheat was 11,299,000 acres, in 1929-30 it was about the same, *viz.*, 11,321,000 acres, while in 1930-31 it fell by six per cent. to 10,641,000 acres. The area under improved varieties in 1928-29 was 2,099,000 acres as compared with 2,516,600 in the next year. It declined to 2,448,000 in 1930-31 or 22 per cent. of the area under wheat in the province. Most of it is under Punjab 8A, which accounts for 2,292,400 acres. That under Punjab 11 has declined to 76,650 acres and the rest is under Pusa 4, P. 12 and others. The outturn in 1928-29 was 3,423,000 tons; next year it was 4,208,000 tons and in 1930-31 3,560,000 tons. About 150 comparisons of 8A against a number of other varieties were carried out under irrigation conditions on farms scattered throughout the province and as usual by far the greater number of comparisons were in favour of 8A. Of the wheat crosses referred to in the previous review, four were extensively tested at Lyallpur, Gurdaspur, Montgomery, Hansi, Sirsa, Sargodha and Ludhiana. Two of them were found to be very susceptible to rust and two others, 518 and 516, were definitely better yielders than 8A. Another cross 409 has also given better outturns than 8A. Milling and baking tests showed that in yield of flour 409 and 516 were slightly superior to 8A while 518 was equal to it. In baking qualities 516 was decidedly inferior to 8A, 409 was slightly inferior and 518 was almost equal. In making *chapatis* 516 was very poor, 409 somewhat better and 518 almost as good as 8A. Punjab 8A, the standard variety, is hard to beat. The cultivators' crop of

Durrum wheats grown on strong lands in Gujranwala and Sialkot are usually mixtures of the three types that have been isolated and are known as Nos. 1, 2 and 3. At Lyallpur Type No. 1 has been found to be best agriculturally, and arrangements have been made to raise the level of purity by supplying pure seed of that type. A simplified hot water treatment has been adopted and found to be efficacious against loose smut. Bunt is common in the wheat crops of the Simla hills and Kangra and Kullu valleys. Cases of 30 per cent. loss of crop owing to attacks of this disease have been frequently recorded and it is difficult to find wheat fields in these localities which are quite free from the disease. About 600 maunds in 1929-30 and 12,000 maunds in 1930-31 of pure smut-free 8A seed were supplied to farmers and it is hoped to do this annually as long as necessary.

The UNITED PROVINCES is the second largest wheat-producing province, having 22 per cent. of the wheat area in India and producing nearly one-third of the total wheat crop. In 1928-29 the area was 7,218,000 acres, in 1929-30 7,289,000 acres, an increase of one per cent., while in 1930-31 it was 7,731,000 acres, a further increase of 9·6 per cent. In 1928-29 the yield was 2,500,000 tons, in 1929-30 3,342,000 tons and in 1930-31 2,725,000 tons. The area under improved varieties rose from 1,390,000 acres in the previous year to 1,600,000 and 1,800,000 acres in the two years under review. The chief varieties that are in popular favour are Pusa 12 and Pusa 4, the latter being very much appreciated on account of its rust-resistant character. Pusa 54 is also gaining popularity, because, being a bearded wheat, it is less liable to attack by birds. Other successful varieties are Cawnpore 13, Muzaffarnagar, and Pusa 52.

The CENTRAL PROVINCES AND BERAR is the third important wheat-growing province, having an acreage of about 11 per cent. of the total area in India. In 1928-29 the area sown was 3,310,000 acres but in 1929-30 it fell to 3,098,000 acres after the calamitous rust year and in 1930-31 it rose again to 3,129,000 acres. The yield in the first year mentioned was only 541,000 tons, while in the two years under report it was 617,000 and 641,000 tons. The area

under improved wheats was 8 per cent. of the whole area under wheat in the province in 1928-29, and in the last two years rose to 11 and then 12 per cent, respectively. The chief problems associated with the improvement of this crop are concerned with the production of rust-resistant and high-yielding forms for the main wheat tracts of the north of the province and of rapid maturing types of hard wheat for the southern wheat plain. Considerable progress has been made in these directions and quite new forms are now awaiting field-trial and multiplication. The mass selection of Hawra continues to give good results and the individual selection No. 12 has maintained its reputation. It is, however, becoming quite clear that at present the selection from commonly grown forms is not likely to be particularly effective in securing wheats of higher value to the grower. The problem of improving the crop, therefore, resolves itself into finding better ready-made forms or evolving them by hybridization. Both methods are being tried. Exotic forms have so far not done sufficiently well to merit introduction, but hybrids resulting from the crossing of these with local wheats are under observation and certain fixed crosses have given, on small-scale trials, indications of promise. Of wheat varieties tested, P. 100 is still the best under irrigation and Pissi for the ordinary condition of dry cultivation. Interesting results have been obtained in a study of the root-system of the wheats of the province and there was a considerable difference in the depths to which the roots penetrated in the years 1929 and 1930. This character appears to be associated with the power to resist drought and is obviously of considerable importance in a country where wheat is grown both under conditions of natural rainfall and under irrigation. In the previous two years rust and frost affected the wheat crop adversely and in 1929-30 damage was done by the early cessation of the monsoon and, in the tracts most affected, by the absence of later winter rains. Fortunately, however, the season 1930-31 was favourable both in respect of monsoon and freedom from rust. In the autumn of 1929, the Revenue Department placed Rs. 5 lakhs at the disposal of the Department of Agriculture to make good local deficiencies, and this allowed the purchase of seed from areas in which

the better varieties were established and its distribution in areas not so sown in the past. The area under improved seed from seed-farms and reliable sources under the departmental control was 355,057 acres, an increase of 31 per cent. over the previous year. It was not to be expected, however, that this rapid increase following the calamity of 1928-29 would be continued, but in 1930-31 there was still an increase of 6 per cent. over the previous year.

In BOMBAY the area under wheat was 2,503,000 acres in 1928-29, 2,469,000 acres in 1929-30 and 2,810,000 acres in 1930-31. The outturn in 1928-29 was 499,000 tons, next year 546,000 tons, which is 9 per cent. greater though the area was 1 per cent. less, and in 1930-31, 587,000 tons. Estimates of the total area under improved varieties is not available, though the departmental farms sold seed enough in 1929-30 to sow 11,260 acres.

Breeding work is carried on by the Crop Botanist at Poona, pending the opening of a special wheat-breeding station at Niphad in the Nasik district, where about one-quarter of the total wheat crop in the Presidency proper is grown. The Bansi variety of wheat has received special attention but the improved yielding strains so far evolved appear to be susceptible to rust. District trials indicate that strain No. 809 will prove suitable for Nasik and Nagar. The grain of this wheat is lustrous, the yield is high and it is relatively rust-resistant. Strain No. 103 has not lived up to its promise. An early strain No. 168 and also No. 224 appear to be suitable for West and East Khandesh, respectively. Similarly the latter strain should be the standard wheat for North Gujarat where its character of earliness is appreciated. Efforts to obtain rust-resistant strains have resulted in the selection of these strains and hybridization has been adopted with a view to obtaining rust-resistant wheats having the good qualities of Bansi. The chief improved variety on irrigated areas is Pusa 4, which is popular because of its rust-resisting character. Every year a fresh supply is obtained from Pusa to keep up the quality on the seed-farms, and from these, in the second year under report, 41,000 lbs. of seed was distributed by the Co-operative Department in the eastern areas.

In SIND, the area under wheat was 408,821 acres in 1928-29, 676,813 acres in 1929-30 and 575,000 acres in 1930-31. The outturn in 1928-29 was 82,092 tons, in 1929-30 198,538 tons and 156,000 tons in 1930-31. Botanical work on the improvement of the wheat crop in Sind is now concentrated at Sakrand for irrigated wheats, and at Jacobabad for unirrigated wheats. The original and main line of work, as in the improvement of most crops in India, has been by selection from existing varieties of the crop in Sind. The final selected varieties obtained are C. Ph. 47 (selected Phandani), A. T. 38 (selected Thoree, from North Sind) and G. S. 25 (selected Boojri, from Lower and East Sind). All these selected varieties give at least 20 per cent. greater outturn than the ordinary Sind wheat crops from which they have been evolved. The two first-named are awnless and the latter is an awned variety. In addition to improvement of the local varieties by selection, different varieties of wheats from other parts of India and from other wheat-growing countries of the world, *e.g.*, Australia, Canada and the United States of America, have been imported into Sind for the purpose of acclimatization and adoption. The best known and most important of these importations are the famous Pusa wheats. The variety Pusa 12 is already well established among the wheat-growers of North Sind, and other high quality Pusa wheats, notably Pusa 4, Pusa 52, Pusa 111 and Pusa 114, appear to be well suited to Sind conditions. Other successful importations include Punjab 8A and Punjab 11, two valuable wheats from the Punjab, Manitoba No. 1, the world-famous strong wheat of Canada, and Bina wheat from the North-West Frontier Province. Experimental work carried out in previous years had indicated that, as a general rule, the selected strains of Sind wheats, *viz.*, C. Ph. 47, A. T. 38 and G. S. 25, were higher yielders than any of the imported varieties although certain of the Pusa types, notably Pusa 12, approached them very closely in this respect. During the *rabi* season of 1930-31, a series of wheat varietal tests were carried out throughout Sind in order to obtain the fullest information with regard to the yields of the improved varieties under trial in district conditions. In all twenty-nine centres were utilized for these

tests, nine under unirrigated conditions and twenty under irrigated conditions. The main conclusions drawn from this series of tests are as follows :—With regard to "Bosi" wheats A. T. 38 is the highest-yielding wheat under "Bosi" conditions in North Sind, C. Ph. 47 standing next. Under these conditions Pusa 12 is definitely low-yielding. In Lower Sind, C. Ph. 47 variety gives the best outturn, and among awned wheats, Punjab 8A and Punjab 11 are both superior to G. S. 25.

With regard to irrigated wheats, C. Ph. 47 is the highest-yielding in North and Central Sind. In East Sind, C. Ph. 47, Punjab 8A and A. T. 38 are approximately equal in this respect. Pusa 12 and Pusa 114 are not far behind C. Ph. 47 in point of yield under irrigated conditions in Central Sind. Although further work must throw additional light upon the results obtained from this series of tests, the data obtained therefrom in the past season will be of the utmost assistance to the agricultural department in fixing a definite policy for the extension of improved wheat varieties in the Barrage areas.

In BIHAR AND ORISSA, the area has remained practically stationary for the three years but the yield was poor in 1930-31, *viz.*, 454,000 tons from 1,213,000 acres. The area under improved varieties has increased from 5,198 acres in 1928-29 to 23,206 acres in 1930-31. Pusa 52 is the most popular variety and is extending both on irrigated and unirrigated land in all the wheat-growing tracts of the province but, as in some years it is liable to severe attacks of rust, it cannot be regarded as an ideal wheat. Some of the new selections made at Pusa are being tried and of these Pusa 112 and 113 are at present the most likely to prove suitable. Pusa 80-5 also is being grown to some extent in North Bihar.

In the NORTH-WEST FRONTIER PROVINCE, the area was the same in 1929-30 as in the previous year, *viz.*, 1,057,000 acres, but in 1930-31 it fell to 890,000 acres. The yield in 1928-29 was 231,000 tons, in 1929-30 248,000 tons and in 1930-31 216,000 tons. There were about 330,000 acres under improved varieties. Pusa 4 continued to be the most commonly cultivated variety on fertile irrigated ands and Federation on the richest single crop lands. Continued

trials at Tarnab have shown that irrigated wheat is generally most profitable after maize. A new sample of Federation wheat imported from Australia proved to be more severely infected by rust than almost any wheat that has been tested at Tarnab for the last twenty years. On the other hand, the old type of Federation grown on neighbouring land was entirely free from rust. The occurrence is of interest and seed of the old and the new Federation has been sent to New South Wales to be grown for comparison. Pusa 4 grown in the North-West Frontier Province gained the first prize in the milling and baking tests of world wheats carried out by the Department of Agriculture, United States of America.

In GWALIOR the area under wheat was 1,021,000 acres in 1928-29, 943,000 acres in 1929-30 and 1,127,000 acres in 1930-31, *i.e.*, 3·5 per cent. of the wheat area in India. The object of the Botanical Section has been to select high-yielding varieties by comparing the yield of promising wheats, with Ekdania as control. G. D. 9, G. D. 10, G. D. 11, G. D. 15 and G. C. 2 were tried. The average of the first four years tends to prove that G. C. 2 is still the highest yielder. In Durum wheats G. D. 11 and G. D. 15 are good yielders and therefore recommended for further distribution.

In PATIALA, the State Agricultural Department distributed seed of Maharaja wheat. It is the highest yielder, both in grain and *bhusa*, the bran is comparatively much less than in other wheats, is less liable to attack by weevil while in store and fetches a higher price in the market. In 1930-31 the area under the Maharaja wheat in Mansa and Dhuri Circle (5 tehsils) was 45,960 acres.

3. Cotton.

As a consequence of the unfavourable prices obtained for Indian cotton during the preceding seasons, the area under cotton in India fell from 27,053,000 acres in 1928-29 to 25,692,000 acres in 1929-30, a decrease of 5 per cent.; and again in 1930-31 to 23,616,000 acres—a further decline of 8 per cent. The ascertained area under improved varieties fell from 3,836,052 acres in 1928-29 to 3,000,914 acres in 1929-30 and then rose to 3,809,647 acres in 1930-31. The total

estimated yield for 1928-29 was 5,811,000 bales (of 400 lbs.), for 1929-30, 5,260,000 bales and for 1930-31, 4,820,000 bales. The first of the two seasons under review was on the whole fair and the second good, the average yield per acre being 79 lbs. and 82 lbs. respectively. The number of bales pressed in 1928-29 was 5,039,000, as compared with 5,240,000 in 1929-30 and 4,904,859 in 1930-31. If to this were added the unpressed cotton received direct by the mills and the cotton used for domestic purposes, the actual crop of each season would be raised by about a million bales above the forecasted crop. The year 1929-30 was remarkable in several respects. In common with all commodities the price of cotton fell precipitously during the year, the fall in the price of Indian cotton being relatively greater than the fall in the price of American. In consequence, Indian cotton was comparatively cheaper than American during a greater part of the year and the heavy export off-take, which marked the previous season, continued throughout the season under review, the total exports for the season being 3,863,000 bales as against 3,933,000 bales of the previous season. More important, however, was the increased consumption of Indian cotton both in India and abroad which reached 6,087,000 bales, a figure which is more than the highest ever reached before by over half a million bales. Unlike the preceding season the price of Indian cotton during 1930-31 was relatively higher than that of American, and this caused a reduction in exports to 3,729,000 bales. For the same reason the world's consumption of Indian cotton fell to 5,860,000 bales in 1930-31. The number of bales of Indian cotton taken up by Indian mills also decreased to 2,269,359 bales, due chiefly to the scarcity of the better types of Indian cotton during the season.

THE INDIAN CENTRAL COTTON COMMITTEE, which was constituted in 1921 as an advisory body and later incorporated under the Indian Cotton Cess Act of 1923 with funds of its own, continued to devote attention to the work of the improvement and development of cotton-growing, marketing and manufacture of cotton in India. Though all branches of the cotton industry are represented on the Committee, the interests of the millions of cotton-growers of this

country have been its foremost consideration and every research scheme sanctioned and all legislation recommended have had the good of the grower in view. From its very inception the Committee was convinced that improvements in the quality of cotton through scientific research would benefit the grower only if the abuses in the methods of marketing against which he was helpless were at the same time checked. Recourse to legislation was therefore necessary. The Indian Cotton Transport Act, the Indian Cotton Ginning and Pressing Factories Act, the Bombay Cotton Markets Act and such other enactments in British India and similar measures in the Indian States have all had their inspiration and the strongest support from the Committee. A brief summary of the work so far done by the Committee and the nature and scope of the further work on hand has been recently published as a brochure entitled " The Present Position of the Research Schemes financed by the Indian Central Cotton Committee ".

The Cotton Transport Act, which was passed by the Government of India in 1923, enables local governments to prohibit the import of inferior cotton, for purposes of mixing and substitution, into areas where superior cotton is grown. The local governments of Bombay, Madras and the Central Provinces have protected under this Act areas growing some of the very best cottons in India. The Indian States of Baroda, Rajpipla, Chhota Udepur, Sangli, Hyderabad and Indore have likewise introduced legislation on similar lines to protect tracts growing better varieties of cotton. In the BOMBAY PRESIDENCY, three zones in the Surat tract, and three in the Kumpta-Dharwar tract were notified in August 1923. A seventh zone, known as the " Narbada-Mahi Zone " was notified in 1931. The Act has worked satisfactorily in these areas and has been responsible for rehabilitating the reputation of the cottons coming from them. The question whether 1027 A. L. F. or 1 A. cotton is more paying to the cultivator in the Surat area still continues to engage the attention of the Committee. Opinion on this point is sharply divided and the Committee wishes to consider all possible data bearing on the problem, before giving an opinion on such an important question.

In 1925, the Cotton Transport Act was applied to three areas in the Madras Presidency, *viz.*, the Tirupur-Cambodia area, the Tinnevelly area and the Northerns and Westerns area. In September 1928, in deference to the wishes of the trade, the Government of Madras amalgamated the first two areas. The effect, as anticipated, was far from being in the best interests of the growers of better type cottons in this area. The Committee is keeping a watchful eye on the effect of the amalgamation.

Since there is at present no restriction on the movement of cotton by road and river, it is reported that inferior cotton from Mysore was brought by merchants first to Hosur by cart and from there by rail to Tirupur to mix with Cambodia. Considerable quantities of cotton from the Hyderabad State were also brought to Adoni and Kurnool by road and river and Pulichi cotton seed was imported into parts of Ramnad and Tinnevelly for sowing.

In February 1930, the Government of the Central Provinces duly notified under the Act an area comprising the districts of Buldana, Akola, Amraoti, Yeotmal, Wardha, Chanda, Nagpur, Chhindwara, Seoni and Bhandara, where the better types of Oomra cottons are grown. This should be of some assistance in the marketing of the newly introduced improved Verum cotton and should free it from the danger of being mixed with inferior types from outside the tract.

Similar legislation has also been put into force in some of the Indian States. In Baroda, the three areas protected in 1923 under the State Act to correspond with the Gujarat Zones were maintained without change. In the Rajpipla and the Chhota Udepur States, legislation on the lines of the Cotton Transport Act continued to work satisfactorily. These two States have further made it compulsory that no variety other than 1027 A. L. F. should be grown within their territories. Hyderabad State notified the Kumpta area of the State, in the south of the Raichur district, as a protected area under the State Cotton Cultivation and Transport Act of 1929. The Hyderabad Gaorani area was also extended to the north to include the Hadgoan Taluka. The Indore State Cotton Transport Bill to which reference was made in the last year's Review has now passed

into law, and the area growing the valuable Malwa cotton has been notified under the Act. To keep out the inferior cotton of the Sholapur district from the State territories, the Sangli Durbar adopted in July 1930 similar measures to those of the Bombay Government in regard to the Kumpta-Dharwar protected area.

Six years have now passed since the Cotton Ginning and Pressing Factories Act came into force. The Act worked smoothly during the period and the few cases of infringement were reported to the authorities concerned. As stated in previous reviews, the most remarkable feature of this piece of legislation is the unstinted support it has received from the Indian States, large and small. Legislation on the lines of the Act in British India is now in force in 58 Indian States.

Reference has been made in previous reviews to the investigations carried out by the Committee into the finance of the cotton crop up-country and its marketing and to the recommendations made by the Committee to local government upon the reports of these investigations. The Central Provinces Government have amended the rules under the Berar Cotton and Grain Markets Law to rectify the defects pointed out by the Committee. The Punjab report has been translated into Urdu and published. The enquiry into market practices is still in progress.

Primary cotton markets. Further progress has been made in this matter also. The Hyderabad Agricultural Markets Bill was passed into law, and the Rules under the Act have come into force. The Rules under the Bombay Cotton Markets Act have now been finally adopted and, as requested by the Committee, are being translated into the local vernaculars. In the Holkar State a regulated cotton market has been established in Indore city. Reference has been made in the previous paragraph to the steps taken by the Madras and the Central Provinces Governments regarding legislation.

Marketing of Improved Varieties of cotton. As in previous year, the Committee continued to keep the trade posted with the progress made by the agricultural departments in the introduction of improved varieties of cotton through the medium of the *Technological Reports on Standard Indian Cottons*, and by means of the note

on the subject contributed to the Bombay Cotton Annual. Through the courtesy of the East Indian Cotton Association it was possible to complete the set of replicas of their official standards sent to the Manchester Cotton Association. Bombay standards for Sind and Punjab cotton, tenderable under Fully-Good, Machine-ginned Bengals contract, and Punjab-American cotton tenderable under Fully-Good, Machine-ginned Broach contract, are now available at Manchester to any one interested in these cottons.

Means to prevent the introduction of foreign cotton pests. The Committee continued to control the fumigation of American cotton at Bombay. During the season 1929-30 the imports of American cotton amounted to 12,759 bales compared with 10,942 bales in 1928-29. For reasons stated in a previous paragraph the imports of American cotton during 1930-31 were high amounting to 128,845 bales. In consequence of the savings effected in dealing with a large quantity, it was possible to recommend a rebate of fumigation fees at the rate of 8 annas per bale on all cotton fumigated during the financial year 1930-31. During the second year under review a reduction was also made in the fumigation charges on round or half bales. As a result of the recommendations made by the Committee in 1927, the Government of India have now prohibited the import of cotton seed by sea for any purpose other than experimental and that too, only by certain officers especially empowered in this behalf.

Cotton Statistics. The Committee continued to compile and publish monthly statements relating to the consumption of Indian raw cotton in mills in British India and in Indian States, the quantity of loose cotton received direct into mills in British India and a weekly statement regarding the purchases and import of American cotton. Since April 1930, a consolidated monthly statement showing the total consumption of Indian raw cotton in British India and Indian States during the month and since the commencement of the season, with corresponding figures for the previous season, is also being released for publication in the press. Further improvement in the consumption statistics compiled by the Committee has been made possible by all the Indian States and Pondicherry agreeing to supply

to the Committee monthly statements showing the actual quantity of raw cotton consumed in the mills situated in their respective territories.

Cotton Research. The efforts of the Committee to improve the marketing of Indian cotton, thus ensuring better returns to the grower, have been referred to in previous paragraphs. The Committee's work does not, however, stop there. From the time it was provided with cess funds the Committee has initiated schemes for the improvement of the quality and yield of the crop in different parts of the country, the study of the pests and diseases of cotton and how to check or prevent them as well as fundamental research into the cotton plant. These research schemes have cost over Rs. 40 lakhs during the last eight years. Of this amount over Rs. 14 lakhs represent the expenditure incurred on technological research, while about Rs. 24 lakhs have been spent on agricultural research. The latter sum comprises over Rs. 14 lakhs spent on the various research schemes financed by the Committee in the Provinces and the Indian States, the balance being the cost to the Committee of the Institute of Plant Industry at Indore.

Technological Laboratory. At the outset of its work the Committee realised that a properly equipped laboratory, where the fibre properties and spinning qualities of newly evolved strains of cotton could be determined at an early stage in the evolution of the strain, was indispensable. A technological laboratory was therefore established in 1924 at Matunga, Bombay. That its services in this respect are appreciated by the plant-breeders is evident from the increasing number of samples sent for test. From 46 in 1924-25 the number of samples rose to 212 in 1930-31. In addition to this, tests on standard Indian cottons were carried out. These tests are all related to the one fundamental problem, *viz.*, the determination of the quality or intrinsic value of a cotton as distinct from its market value. The results were published in the *Technological Reports on Standard Indian Cotton, 1930.* Special tests were also carried out during the year on Banilla and Karunganni cottons to determine the extent of the alleged gradual deterioration in spinning value in the former, and to ascertain how adulteration with Pulichai cotton

affects the spinning capacity of the latter. The results obtained confirm the suspicions previously entertained. Further tests will be carried out next season and the results published. During recent years the Laboratory has been carrying out work which is of direct benefit to the trade and the mill industry and there is every prospect of further development in this direction. During 1930-31, 27 samples representing the average commercial crop as selected by the Standards Committee of the East India Cotton Association, and 21 samples of the first arrivals of the season of different cottons supplied by the Millowners' Association of Ahmedabad and Bombay were tested and their results published in " Technological Circulars " Nos. 35 to 58. Observations on the variations in the weight of cotton bales of different trade descriptions, and a thorough investigation into the normal moisture-content of bales are being conducted at the Cotton Exchange, Sewri, under the auspices of the East Indian Cotton Association. Of greater immediate importance to the Indian mill industry is the series of spinning tests begun at the Laboratory on Indian staple cottons combed to different degrees. Preliminary results show that Punjab-American 289 F. cotton combed to the extent of 20 per cent. spins 60*s* and a 30 per cent. combed sample spins 80*s* as against 44*s* of an uncombed sample. With the increasing demand by Indian mills for staple cottons of finer counts, much of which is at present imported, the results of these tests should be of great value. Similar tests on Cambodia, Nandyal 14, and 1027 A. L. F. are now being done. The main work of the research side of the Laboratory is to try and correlate fibre properties with spinning value. Considerable progress has already been achieved. The results of this branch of work are published from time to time in the *Journal of the Textile Institute.*

THE INDORE INSTITUTE OF PLANT INDUSTRY was started in 1924 mainly as a central research institute for cotton. The programme of work includes fundamental research into cotton as well as investigations into the general agricultural problems connected with cotton-growing on the black soils of Central India. Up to date attention has been concentrated on the latter part of the programme. Improved methods of cultivation, crop-rotation and the manu-

facture of a cheap compost manure, the making of which is within the means of every cultivator, have been worked out and brought into practice. The adoption of these methods has trebled the yield of cotton at the Institute. In order to bring these results to the notice of the growers for incorporation into general agricultural practice, annual meetings are held to which large numbers of cultivators are invited. Training is also given to *kamdars* and to revenue officials in the methods employed at the Institute and in this way it is hoped to spread the improved methods by means of men trained in the work.

In addition to the Central Research Institute at Indore, the Committee is at present financing 15 schemes for the betterment of Indian cotton. Six of these schemes are connected with the selection and breeding of new varieties of cotton for the more important tracts in India while 3 deal with physiological, 4 with entomological and 2 with mycological problems, two more schemes have been sanctioned, one to investigate the Punjab white fly and the other with root-rot in Baroda. The following is the list of the schemes and each will be dealt with in its appropriate place as the work of each Province and State is being considered :—

Botanical.

(1) The Madras Herbaceum Scheme.
(2) The Punjab Botanical Research Scheme.
(3) The Khandesh Cotton-breeding Scheme.
(4) The Hyderabad Botanical Scheme.
(5) The Gang Canal Botanical Scheme.
(6) The Burma Cotton Improvement Scheme.

Mycological.

(1) The C. P. and Berar Botanical (wilt-resisting) Scheme.
(2) The Dharwar Wilt-Scheme.
(3) The Baroda root-rot Scheme.

Physiological.

(1) The Madras Pempheres and Physiological Scheme.
(2) The Surat Physiological Scheme.
(3) The Sind Physiological Scheme.
(4) The Madras Fodder Cholam Scheme.

Entomological.

(1) The U. P. Entomological Scheme.
(2) The Punjab Entomological Scheme.
(3) The Surat Entomological Scheme.
(4) The Madras Pempheres and Physiological Scheme.
(5) The Punjab White Fly Scheme.

In the BOMBAY PRESIDENCY breeding work is in progress at five centres, namely, Surat, Broach, Viramgam, Dhulia, and Dharwar. Reference has been made in previous reviews to the promising type of cotton known as Surat 5 which, obtained as a result of the work at Surat, appeared to be superior to 1027 A. L. F. in all respects except in the opening of bolls. In 1930-31, however, it proved disappointing by giving weak yarns when spun in spite of its superior fibre properties. The object of the breeding work at Broach is to evolve a wilt-resistant long staple cotton with a ginning percentage equal to that of the local variety, and now several crosses are under observation. At Viramgam in the Dholleras tract, the most promising cotton so far evolved is the strain known as Wagad 8, obtained by straight selection from the local Wagad cotton. At Dhulia in the Khandesh tract in 1926 the Indian Central Cotton Committee provided funds to give a thorough test to some Bani-Comilla crosses which had been in the hands of the Agricultural Department for many years. One of these, since named Banilla, gives a similar yield, a higher ginning outturn, and produces a better lint than the local N. R. cotton. It was at first suitable for spinning 20*s* counts but gradually it has deteriorated; till now it is adjudged suitable for 13*s* only. In spite of this, however, the seed of this type is in great demand among the cultivators as it is still more profitable than the local N. R. cotton.

With the object of determining the cause of the large amount of shedding of buds, flowers and bolls and to devise measures to reduce some at least of the loss, the Indian Central Cotton Committee provided funds in 1923 to start an investigation at Surat. Very interesting results regarding the causes of the heavy losses have been obtained, but it has not been possible to suggest any remedial measures for rain-fed areas. The shedding of buds, flowers, and bolls is due to the competition between different parts of the plant for the available plant food, mostly nitrogen, at the time when the heavy flush of flowers appears. The application of a quick-acting nitrogenous manure late in the season helps a larger proportion of flowers to ripen into bolls if suitable soil moisture conditions prevail, but this is feasible only where the moisture-content of the soil can be controlled and not under rain-fed conditions as in Surat. Boll-shedding has been found to be hereditary to a certain extent and plant-breeding methods could be employed to overcome this tendency. From the results of an investigation since 1923 of the spotted bollworms (*Earias fabia* and *insulana*) which cause enormous loss in the cotton crop of these tracts, it has been proved that the only practical method of prevention is to maintain a " close " period, and a scheme to extirpate the pest from an area of 480 square miles has been worked out. It consists of an intensive cleaning up, immediately after harvest, of all cotton stalks and stubble and alternative host plants. It is hoped to launch this scheme as soon as the conditions in Gujarat permit of its receiving the co-operation of all concerned. As a preliminary, the Committee sanctioned a grant for propaganda in the area, to educate the public on the value of maintaining a " close period " between two crops of cotton. At Dharwar in the Kumpta-Dharwar tract where attention has been paid to the breeding of wilt-resistant types, the Agricultural Department is distributing a type known as Jayawant which is wilt-resistant and is at the same time as good in lint qualities as Dharwar 1, the existing improved variety, which, however, is susceptible to the disease. Further work with other wilt-resisting types is also in progress. One of the chief activities of the Department in Bombay is to organize the seed-supply

of improved types of cotton. An important development which took place during the period under review was the decision of the Indian Central Cotton Committee to subsidize work of this character. Substantial subsidies were accordingly granted for the extension and distribution of seed of Jayawant, Gadag 1, Dharwar 1, Dharwar 1 × Rosea and 1027 A. L. F. in the different tracts for which these cottons are suitable. In all about 5 million pounds of seed were handled in these schemes. In addition, the Department made their own arrangements for the distribution of N. R. and Banilla seeds in Khandesh and 27 W. N. and 4-F seeds in Sind, the total weight handled being about 7 lakhs of pounds.

In SIND attention was concentrated on the investigation of certain problems connected with the water requirements, sowing dates and the general physiology of the cotton plant under perennial irrigation in anticipation of the change from inundation to perennial irrigation under the Lloyd Barrage. Experiments already carried out with different varieties of cotton show that it would be much better to concentrate on the hardy indigenous types rather than on exotics.

Considerable work had been done on the cotton of the CENTRAL PROVINCES before the Indian Central Cotton Committee in 1923 agreed to finance a scheme for obtaining a wilt-resistant, better-yielding cotton for the Central Provinces and Berar tract, so that results have already become available. Verum 262, the type now being released for general cultivation, is a most desirable cotton. It spins 20*s* to 22*s* against the ordinary Berar's 8*s* to 12*s* and fetches a good premium on Broach. The seed of this type is in great demand among the cultivators. The Local Government in 1928-29 gave a loan of Rs. 50,000, which was increased to two lakhs in 1929-30 and to 4·5 lakhs in 1930-31, to the Department to help to market the crop and to ensure an adequate supply of pure seed, and in 1930-31 the Indian Central Cotton Committee gave a grant of Rs. 4,000 for additional staff for this purpose. It is anticipated that the whole area of cotton in the Central Provinces and Berar amounting to about 5 million acres will soon be brought under this new type, and on a modest estimate each acre is expected to yield

an extra profit of Rs. 10 to the grower. Further selection work has also been in progress with a view to obtain types suitable for the eastern portion of the Provinces and for the Northern and Plateau districts for which Verum 262 is unsuitable on account of late rains and early frosts respectively. This has also been successful. Another part of this scheme consisted of an investigation into and a remedy for the low yields of cotton in Berar and a suitable rotation, with groundnut as one of the crops, has been worked out which adds considerably to the yield of the cotton crop. The Mycological Section continued its physiological studies on cotton *fusaria*. Though the study has not been completed, the tentative conclusion arrived at is in line with the results of the experiments in Egypt, *viz.*, that the *fusaria* responsible for wilting in Dharwar, Egypt, America and the Central Provinces are all different from one another. The seedling blight of cotton has for some time past been under study. Further observations made during the year show that the causal organism is chiefly a species of *Rhizoctonia*. An unusual phenomenon the Department was called upon to investigate during last season was the dying of mature cotton plants in Berar. Texas Root-rot was suspected to be the cause, but the American authorities to whom specimens were sent did not find any trace of this disease. It was, therefore, thought that the unequal rainfall distribution during the season might have caused this trouble. The investigation into the pink bollworm problem was continued at Akola. It was noticed that the seed of the last picking harboured more hibernating bollworms than that of earlier pickings. The treatment recommended to control this pest is to expose the seed in thin layers to the heat of the sun during May.

In HYDERABAD STATE every effort is being made to improve the quality and quantity of the cottons grown there. In 1929 a scheme financed by the Indian Central Cotton Committee was started with a view to producing a type which will be as good as Gaorani in its lint qualities and as profitable to the grower as Roseum. Considerable progress has been made in these two years and a number of selections are under observation. A great effort was made by the Department of Agriculture to oust the existing types,

by distributing seed of Gaorani, Gadag, 1, Dharwar 1 and Verum 262 in areas suitable for these types. It is estimated that in 1930-31 about 115,000 acres have been sown with seed distributed by the Department.

At Lyallpur in the PUNJAB, the study of the problems connected with cotton-growing in the Canal Colonies was continued. Investigations into the causes of the " failure " of American cotton in the Punjab show that it is mainly pathological, induced by the unfavourable climatic conditions during the period of growth of the plant. It appears that the best way of overcoming this difficulty is to produce a type of plant resistant to the harmful effects of these adverse conditions. Pending the distribution of any new strains evolved, the rogueing of commercial crops on the farms of certain large estates is being carried out on a large scale in order to produce a nucleus of pure seed for distribution. Until last season it appeared that the Cotton Research Botanist had obtained a type known as Early Strain which was not susceptible to the adverse conditions which cause the " failures " and which was in every other respect a most desirable cotton, but a severe attack of Jassids during the season 1930-31 revealed the fact that this type was susceptible to Jassid attack. It therefore became necessary to concentrate attention on Jassid-resisting types, of which fortunately material is available, and work on these is now in progress which with the help of a grant recently made by the Indian Central Cotton Committee will be prosecuted with diligence as the successful solving of these problems is of inestimable importance to the Punjab. A scheme was started in 1926 to ascertain the cause of the difference in the incidence of the pink bollworm in the South-East Punjab, where it is serious, and the Canal Colonies, where it is negligible. The conclusions arrived at are that the source of infestation is, as in the United Provinces, the seed and that the difference in the incidence is chiefly due to the difference in the temperatures of the two tracts. It was found that at temperatures of 40° C and above the longevity of moths, oviposition and hatching are considerably restricted, and that caterpillars hibernating in seed can be killed by exposing the seed in thin layers to the heat of the sun during the months of

April and May. This is a simple and practical method of control within the means of every cultivator. In addition, observations on the bionomics and alternative food-plants of the spotted boll-worm during the year under report showed that the flower-buds and fruits of *bhindi* and hollyhocks attracted a large number of these insects throughout the fruiting season. The results of sowing-date experiments in previous years had favoured late sowing, but during the year under report late-sown cotton suffered most from Jassid attack. The results of further manurial experiments on the effect of applying a quick-acting nitrogenous manure at a late period in the plant's development show agreement with the observations made at Surat that a top dressing of ammonium sulphate about the end of August is really paying.

At Koilpatti in MADRAS a superior strain of Karunganni and at Guntur a good strain of Cocanadas have been isolated and are now on trial under cultivators' conditions. The problem at Nandyal is to combine the superior lint qualities of N-14 with larger yield, but so far not much success has attended the attempt. Further trials on Avanashi on ryots' lands confirm previous observations that early sowing of Cambodia cotton produces a heavier yield. At Coimbatore the effort to evolve by cross-breeding a type of cotton as hardy as Uppam (*G. herbaceum*) and as good in staple as Karunganni (*G. indicum*) must necessarily take some years to produce results. The area of cotton that will be benefited is about 800,000 acres and the tract is notorious for its light and precarious rainfall. The Pempheres and Physiological scheme has been held in abeyance for some time for lack of trained staff; but two officers from the Madras Agriculture Department are to be sent to England for the necessary training, and preliminary work has been commenced under the supervision of the Cotton Specialist, Coimbatore, pending the return of the two officers. The scheme consists of two parts, one to try methods of combating the cotton stem borer (*Pempheres affinis*) and the other to investigate the reasons why the borer prefers certain varieties to others. Another physiological scheme financed by the Indian Central Cotton Committee was started in 1930 to investigate the cause of the poor yield of cotton when grown in rotation with

fodder *cholam* (*Andropogon Sorghum*) a phenomenon which does not occur when *cumbu* (*Pennisetum typhoideum*) is the alternative crop. A grant was made by the Indian Central Cotton Committee for the distribution of Cambodia cotton seed.

In the UNITED PROVINCES the introduction of superior varieties of cotton with a view to meet the demand of the local mills has for long been the object of the Agriculture Department. In consultation with the Upper India Chamber of Commerce, the Department has decided to concentrate on the two varieties known as C. 402 and C. 520. The former is distinctly superior to Bengal, being about $\frac{7}{8}$" in staple and capable of being used in 18*s* mixing. The chief difficulty now experienced is, however, the organisation of proper marketing facilities for the produce and the ensuring of adequate premia for the quality of the growers of improved type to compensate them for the lower yields obtained. Every year enormous damage is done to cotton in several parts of India by the pink bollworm which is the worst pest of cotton in India. The United Provinces Entomological Scheme was started in 1923 with the object of determining the amount of damage done by the pink bollworm and of devising suitable control measures. The work of the first few years clearly demonstrated that the damage to the United Provinces cotton crop from this pest ranged from 25 to 75 per cent. and that the remedy for preventing the re-infection of the crop which generally arose from live larvae carried in double seeds consisted in heating the seed to about 60° C. which was sufficient to kill the larvae without affecting the viability of seed. For the eradication of the pest, therefore, it was found that all seed in any selected area should be heat-treated. In 1929-30 an area of 23,000 acres of cotton was thus controlled in the last cotton season in Atrauli tahsil of Aligarh district, and the general opinion on the crop was that it was the best produced within living memory. Next year an area of 27,000 acres was sown with treated seed and it is estimated that the growers obtained an average increased yield of 50 per cent. in addition to a much better price for their produce. A scheme to extend these operations to the whole of Aligarh district is now under consideration.

The Agricultural Department of the BARODA STATE continued its policy of distributing pure seed of 1027 A. L. F. in the Navsari district. In the Baroda district it was found necessary to organise the seed-supply of Broach 91 as, in spite of the advice of the Bombay Department of Agriculture, the growers and ginners preferred this type to Deshi. In the Mehsana district a year's trial has shown that 1027 A. L. F. thrives well under irrigation. In the Amreli district Banilla has been found more suitable than local Mathio.

On the Central Farm at Ujjain in the GWALIOR STATE, the varietal trials with cottons expected to compete with the local Malwi cotton and selection work to evolve a good strain of Malwi cotton as well as manurial tests were continued during the year under review.

The attempt to incorporate into general agricultural practice the experience gained on the Mahlaing Farm in BURMA is being intensified by the Cotton Improvement Scheme sanctioned by the Indian Central Cotton Committee. Selection work on Wagali, Wagyi and Cambodia cotton is in progress and plant-breeding work is also in progress.

In the MYSORE STATE much research work is in progress on the Hiriyur Farm, *viz.*, trials to find wilt-resisting types, hybridization and selection work on indigenous and exotic cottons, and the study of inheritance of certain characters.

In INDORE STATE the Rural Development distributed considerable quantities of seed of selected Malwi, Verum and N. R. cottons in the Malwa Plateau, in the low country and in the Nemad district, respectively.

In BIKANER a small scheme financed by the Indian Central Cotton Committee was commenced in December 1930 with the object of obtaining by selection and hybridization improved types of Indian and American cottons suitable for cultivation in the canal irrigated areas and capable of spinning at least 25*s* counts.

In BENGAL an attempt is being made on the Rangamati farm to select the best cotton from the local types.

Co-operative Cotton Sale Societies. In a previous paragraph reference has been made to the Cotton Finance and Marketing

Enquiries conducted by the Indian Central Cotton Committee and the recommendations made to the Local Governments concerned on the reports of these investigations. A common feature of these recommendations was that all the Governments, *viz.*, of Bombay, Madras, Central Provinces and the Punjab were requested to help the development of co-operative cotton sale societies to provide the growers with a better outlet for their produce. During the year under review, 25 cotton sale societies functioned in the Bombay Presidency and cotton worth over 45 lakhs of rupees was handled by them. Most of these societies now act as a medium for the extension of improved varieties of cotton introduced by the Department of Agriculture, and the formation of more societies is to be welcomed from this aspect alone. In the Madras Presidency, the Loan and Sale Societies handled cotton among other agricultural produce. The Government appointed an officer in the grade of a Deputy Director of Agriculture to work under the Registrar of Co-operative Societies to give the technical assistance required by cotton sale societies, for grading and keeping under control the production and redistribution of pure seed of good strains and for the cultivation of cotton. There are at present five societies in the Presidency dealing in cotton. Besides these, there are a number of registered and unregistered seed societies and unions who obtain seed of improved types of cotton from the Agricultural Department, grow and dispose of the produce under departmental control, the Department buying back the seed at a premium. In the Mysore State there is only one society at Maradihalli dealing in cotton. The cotton handled by this society was Selection 69. In the Baroda State 17 societies with a total membership of 1,036 worked during the last season, ginning and selling co-operatively about 1,713 *bhars* of seed cotton.

4. Sugarcane.

The area under sugarcane in the various provinces and Indian States was 2,568,000 acres in 1928-29, 2,513,000 acres in 1929-30 and 2,785,000 acres in 1930-31, a decrease of 3·2 per cent. and then an increase of 10 per cent. in consecutive pairs of years. The produc-

tion of raw sugar (*gur*) was estimated at approximately 2,704,000 tons in 1928-29, 2,752,000 tons in 1929-30 and 3,193,000 tons in 1930-31.

Twenty-nine factories making sugar direct from cane worked in India during the season 1930-31, as against twenty-seven in the previous season and twenty-four in the year before. Eleven of these are situated in Bihar and Orissa, thirteen in the United Provinces, two in Madras and one each in Bombay, the Punjab and Burma. Recently a new factory in the Punjab started working and plans are ready to start several others in the white sugar tract next year. The production of sugar direct from cane by factories in India totalled 68,040 tons in 1928-29, 89,768 tons in 1929-30 and 119,859 tons in 1930-31, thus showing an increase of 32 and 33·5 per cents. in successive seasons. The average percentage recovery of sugar from cane in India also shows an improvement, having risen from 8·59 in 1927-28 to 9·07 next year and to 9·09 in 1930-31. It is gratifying to note that the general efficiency of the factories making sugar direct from cane is steadily increasing. Out of the twenty-nine factories that worked in India during the season 1930-31, the percentage recovery of two factories is above 10, of twelve factories above 9, of eleven factories above 8 and of only four below 8.

There are at present thirty-three concerns in India equipped for refining *gur*, out of which nineteen factories also manufacture sugar direct from cane. Of the former only three refined *gur* during the year 1931 and of the latter seven worked during the year. Four were silent and returns from three have not been received. There were thus ten factories refining *gur* as against eleven during the year 1930 and fourteen in 1929. Of the ten factories that refined *gur* during the year 1931, six are situated in the United Provinces, three in Madras and one in the Punjab. The production of sugar from refining *gur* or raw sugar in India was 31,032 tons in 1928-29, 21,147 tons in 1929-30 and 31,786 tons in 1930-31, thus showing a decrease of 32 per cent. and an increase of 50 per cent. in successive years, though the production in 1930-31 was only 2·4 per cent. above that in 1928-29. Thus the total amount of refined sugar manufactured

in India was 99,082 tons in 1929, 110,915 tons in 1930 and 151,645 tons in 1931.

A table is given below showing the production of sugar direct from cane and from refining *gur* during the last twelve seasons and indicating the relative advance in the production of sugar from cane, the recent decline of the production of sugar from *gur* and the steady increase in the home production of sugar.

Production of Sugar.

Year	Direct from cane	Refined from *gur*	Total
	Tons	Tons	Tons
1919-20	23,081	44,453	67,534
1920-21	24,562	48,614	73,176
1921-22	26,929	47,835	74,764
1922-23	23,906	50,210	74,116
1923-24	38,346	56,455	94,801
1924-25	33,835	33,621	67,456
1925-26	53,033	38,440	91,473
1926-27	62,992	58,426	121,418
1927-28	67,739	52,001	119,740
1928-29	67,980	31,005	98,985
1929-30	89,675	21,128	110,803
1930-31	119,736	31,758	151,494

The imports of sugar into India amounted to 868,800 tons worth Rs. 15,85,63,427 in 1928-29, 939,584 tons worth Rs. 15,51,41,924 in 1929-30 and 901,278 tons worth Rs. 10,53,80,827 in 1930-31.

The world production of sugar in the year 1929-30 as given by Messrs. Willett and Gray amounted to 27,316,145 tons showing a decline in production of 245,955 tons as compared with the previous year. The slight decline in crop would have had a slightly hardening effect on the market but for the stock position on 1st April 1929 (6,895,000 metric tons raw value) which made the situation unsatisfactory. Prices of sugar during the year gradually declined and

the Indian markets were also affected and declined on account of large imports of foreign sugar, specially of beet sugar, which increased from 8,000 tons in 1928-29 to 131,000 tons in 1929-30. Again in 1930-31 the world production of sugar amounted to 28,751,837 tons showing an increase of 1,441,257 tons over the previous year. Prices of sugar in Indian markets continued to decline. The price of Java sugar in Indian markets gradually declined in consequence of Java's lowering her prices frequently owing to difficulty in the marketing of her crop of 1930. On the 14th April 1930, the price of Java sugar in Calcutta was Rs. 9-4-3 per maund and the price declined to Rs. 8-1-6 on the 25th November 1930. The market improved from 1st week of January 1931, in anticipation of an increase of import duty on 1st March 1931. The price rose to Rs. 8-15-3 per maund on 31st March 1931. Though the import duty was increased by Rs. 1-4 on 1st March 1931, the market could not rise proportionately on account of heavy accumulation of stocks in private godowns.

The IMPERIAL SUGARCANE BREEDING STATION at COIMBATORE continued the breeding of improved canes and further progress was made both in breeding technique and in studies of the germination of sugarcane pollen, the period of stigmatic receptivity and controlling the times of flowering of the parents. The wild *Saccharums* received some attention with the object of including useful types as parents. An advance of great interest made during the period was the intergeneric hybridization of sugarcane and sorghum. These hybrids that flowered during the season were studied with regard to their inflorescence characteristics, and additional evidence about the genuineness of these hybrids was obtained from the following peculiarities in certain of the hybrids—sorghum-shaped inflorescence, the awned fourth glume and the greenish white stigmas. The hybrids exhibited quite a large number of abnormalities. The Co. numbers of the sorghum hybrids that have been distributed to the various provincial stations for trial are Co. 351 to 357, and under Coimbatore conditions these hybrids ripened in about six months and fair quality *gur* or jaggery was obtained from laboratory samples of the juice. It can now be claimed that these hybrids are likely

to yield short duration canes. The bulk crossing for the breeding of medium or thin type of canes consisted of Co. 213 × Co. 244. This cross was effected as it had yielded canes of considerable promise in North India. Another combination that has yielded promising types is Co. 281 × Co. 290, and the utility of Co. 214 as a parent for introducing early maturity and good sucrose content has again been proved. The frost was rather severe during the 1930-31 season, and certain of the Coimbatore seedlings stood it better than most indigenous kinds in the Punjab. Some of the Coimbatore productions are said to have shown comparative resistance to *Pyrilla* which was very severe in parts of the Punjab and the United Provinces, indicating the possibility of breeding in future canes resistant to this pest. The spread of Coimbatore canes in cultivation in North India has been one of the factors responsible for the increased efficiency of the Indian factories.

From funds sanctioned by the Imperial Council of Agricultural Research a small sugarcane sub-station was started at Karnal, and seeds obtained from crossed and selfed flowers at Coimbatore were successfully germinated at Karnal. These seeds were preserved in an atmosphere of carbonic acid gas before despatching to Karnal. In connection with an investigation at the Sugarcane Research Station at Shahjahanpur, a batch of 5,000 seedlings of Co. 213× Co. 244 was despatched to Shahjahanpur after having been pricked into pans and specially treated to stand the journey. The breeding of thick canes, which started much later than that of medium and thin canes, had reached a stage at which eight selected seedling canes were distributed to nine experimental stations. The numbers of these seedling canes are Co. 358 to Co. 365. Four were despatched to four stations in Northern India for trial as chewing canes. In connection with breeding of thick canes, rather extensive cytological observations were in progress on duplication of the generative nuclei, the development of the embryo and the number of chromosomes in certain varieties. Sugarcane pollen was stored alive for seven days in a pulverulent condition by keeping it over calcium chloride and a temperature ranging from 8°C. to 13°C. This pollen when cultured artificially gave 12 per cent. germination. The

duration of stigma receptivity in certain of the thick cane varieties was found to range from 8 to 11 days.

PUSA. Since Co. 205 had been discarded by the sugar factories, it became a matter of urgent importance to replace this cane. During both seasons the higher sucrose content of Co. 285 (15 per cent. in November against 12·66 per cent. in Co. 205) combined with high tonnage, drought-resisting capacity, rapid growing quality, and other desirable agricultural habits confirmed its superiority over Co. 205. If it turns out well in the large-scale mill trial next season, this variety will be recommended for planting in those parts of the white sugar tract for which it is suitable. Co. 295 and three new canes of this class Co. 317, Co. 318 and Co. 319 were obtained from Coimbatore to test against Co. 285. Co. 299 and Co. 281 gave better results in comparison with Co. 214 which is the standard early cane. Co. 281 is steadily improving and shows signs of becoming acclimatized to conditions in North Bihar. Co. 300, 301, 302, 303, 304, 312, 313, 316 and 331 as well as B. S. 3 and B. S. 11 all show promise. Tonnage experiments designed to compare the yields of Co. 210 and Co. 213 indicated a 15 per cent. increase of Co. 210 over Co. 213, when grown on lighter land. These two varieties of economic value are grown extensively all over North Bihar as well as other provinces. When grown under their most suitable conditions they hold their own anywhere—yet they have their limitations. For example Co. 213 needs considerably greater rainfall and strong soil, while Co. 210 appears distinctly superior on lighter soils. The time has now arrived to separate these canes and grow each under its optimum soil conditions.

In the manurial experiments with sulphate of ammonia and nitrate of soda, the average yields of Co. 210 was 518 and 447 maunds respectively, and of Co. 213, 441 and 399 maunds respectively. Sulphate of ammonia applied at two maunds per acre as a top dressing, in two doses in the middle of January and middle of July, in addition to standard manuring, gave the best results.

To estimate the cost of production on the farm, sugarcane was grown on three different blocks during the year 1930-31 and cost of all operations was carefully recorded. At the New Area the average

cost per acre for growing sugarcane on a block of 28 acres was Rs. 116. This includes Rs. 65 per acre spent on manures. The average yield per acre was 409 maunds and the cost per maund was annas 4·53. In Bhograsan field (ten acres) variety tests, the cost of cultivation amounted to Rs. 98 per acre with an average yield of 445 maunds per acre and the cost per maund was annas 3·52. Twenty acres were planted under Co. 205 in Brickfield II low land as a non-experiment general field crop grown without manure. Whole canes were planted in furrows opened by means of three-row ridger. The average cost per acre was Rs. 49 while the yield amounted to 378·5 maunds. Cost per maund was annas 2·27. A method of safeguarding the seed-supply of early ripening canes was successfully worked out by wrapping them with cane trash.

Rogueing on the farm at Pusa for five years has reduced mosaic disease on all varieties except Co. 205 to eleven clumps in 40 acres of cane but on Co. 205 the disease has been only partially reduced. Fortunately Co. 205 is now a discarded cane. In the test for the natural spread of mosaic, where a row of 50 yards long of each of 25 varieties is alternated with a row of mosaic-infected cane, the old canes were ratooned but no new cases of mosaic disease appeared in any of the test rows. The mosaic disease lowered the weight of stripped cane by 4·6 per cent. in Co. 213 and 8·6 per cent. in Co. 205 and reduced the quality of the juice slightly.

The UNITED PROVINCES contain the largest acreage of cane in India, the area being 1,357,000 acres in 1928-29, 1,362,000 acres in 1929-30 and 1,488,000 acres in 1930-31. The area under improved cane has increased very considerably. The total area under improved cane in the United Provinces was 281,000 acres in 1928-29, 515,000 acres in 1929-30 and 678,000 acres in 1930-31, so that now 48 per cent. of the area is under improved cane. This extension is probably the greatest single achievement of the Agriculture Department during the last few years and shows the eagerness with which cultivators take up a new idea after they are satisfied that it is to their advantage. Another potent factor has also operated to this end. The prices of all the agricultural produce fell considerably but the price paid by the sugar mills for the cane remained un-

changed. Under the present conditions this is the only crop to which the ryot can turn as a revenue crop, and its cost of production can be considerably reduced owing to oil-cake for manuring being available at cheap rates. The present price of oil-cake is Rs. 1-8 per maund in the market as against Rs. 4 paid last year. Co. 213 is said to have deteriorated in the province, but there are ample quantities of other excellent varieties of disease-free canes to take the place of this variety. In 1929-30 the average produce of Co. 213 sugarcane in 10 plots treated with green manuring with *sanai* was about 910 mds. of sugarcane per acre, while the average outturn per acre of the same variety without green manuring was 660 mds. Another variety Co. 243 gave 854 mds. per acre with green manuring and 575 mds. without. The cost of sowing and turning *sanai* per acre is about Rs. 12-5, while the extra yield obtained was about Rs. 94 in the case of Co. 213 and Rs. 104 in the case of Co. 243. There is thus a handsome profit. Green manuring not only benefits the sugarcane crop to which it has been applied, but it leaves a reserve of plant food in the soil which can be utilized by succeeding crops.

BIHAR AND ORISSA. Co. 210, Co. 213 and Co. 214 continued to be most profitable varieties in North Bihar where cane is grown without irrigation, and these varieties are rapidly ousting Hemja and Bhurli. An early application of phosphates at Sepaya in North Bihar not only increased the outturn but also raised the richness of the juice considerably while the late application decreased both the outturn as well as richness of the juice. Nitrogenous application did not make any difference, whether the heaviest dose was applied early at the time of planting or in the rains at the time of earthing up. In South Bihar Co. 213 has spread rapidly in the canal area of Shahabad and in the cane tracts of Gaya and Patna. Co. 205 has proved itself very hardy under adverse conditions, water-logging and flooding, but as it contains much fibre it is a difficult cane to mill, so white sugar factories have in many cases discarded it. The work at Pusa already outlined has, however, showed that Co. 285 can with great advantage take its place and has indicated promising other alternatives. At Sabour experimental

work was carried out on the production of *gur* from palmyra palm juice. The object of this work was to extend the sugarcane *gur* making season. The cane *gur* making is finished by April and at that time there is a plentiful supply of juice in palm. Excellent samples of *gur* were obtained and it is proposed to manufacture white sugar on a small scale next season. The Imperial Council of Agricultural Research has sanctioned a grant of Rs. 1,60,000 spread over five years for sugarcane research. It has also sanctioned a grant of Rs. 8,000 for the design of a satisfactory small power cane-crushing mill the need for which was keenly felt in the province.

PUNJAB. The use of improved canes in the Punjab is now rapidly increasing. The estimated area under Coimbatore canes in 1929-30 was 80,000 acres and in 1930-31 104,400 acres which represents 24·5 per cent. of the total area under sugarcane. Owing to scarcity of good seed at sowing time due to frost, the ratooning of the crop was resorted to in many cases and has given very good results. In order to popularise the cultivation of improved sugarcane varieties, Government sanctioned during the year the free transport of Coimbatore sugarcane sets on a small scale to new growers. The comparative values of the various varieties of cane studied show that in general the Coimbatore varieties are better in every respect than the indigenous, though of the latter Saretha is holding its own in the Southern Punjab. In the Central districts the local cane Katha has yielded on the average about half the tonnage of the Co. varieties. Of the latter Co. 285 is the heaviest yielder, though Co. 281 has the highest sucrose content. In the sub-montane tracts of Gurdaspur and Sialkot, Kahu has yielded the highest tonnage amongst local varieties. Co. 285 had done well everywhere, though Co. 270 and Co. 290 have beaten it in sucrose content and the former also in tonnage. The effect of potassium nitrate, superphosphate, ammonium sulphate and ammonium phosphate was studied on Co. 223 grown at Gurdaspur Agricultural Station. It has been noticed that the weight and the period of maturity of sugarcane were affected by the use of the fertilizers, while the sugar-content changed slightly; that sugarcane manured with potassium nitrate matured early and was least

affected by frost while the application of ammonium sulphate and ammonium phosphate delayed the ripening; and that potassium nitrate and ammonium sulphate have been found to be comparatively more economical than the other two fertilizers. The effect of flowering of sugarcane which is a rare phenomenon in the Punjab was studied on Co. 285. It was observed that the weight of a cane in flower was actually more than that of a flower-less cane without any difference in the amount or quality of juice. The results of the experiments conducted in studying the various methods of preparing *gur* confirm previous experience that brisk boiling is superior to slow boiling and that inversion of sugar depends more upon the PH value of the juice and the time during which boiling is continued than on the temperature. Further work has been done on the clarification of cane juice and the preparation of *gur*, using different clarifiers and different temperatures. From the results got it appears that the phosphatic contents of the juice exercise a considerable effect on clarification, juices low in phosphates clarifying better by the addition of phosphoric acid. The economics of the methods employed have not yet been worked out; therefore the final results have not been published. Investigation on the loss of tonnage in sugarcane affected by mosaic disease was undertaken. The results obtained at Lyallpur seem to show that a definite loss in tonnage results from mosaic infection. On an average the healthy crop appeared to yield 21 per cent. cane, 17 per cent. juice and 21 per cent. *gur*, more than the mosaic-affected crop. The experiment, however, is not conclusive and is being repeated. Owing to the heavy frost in the previous year, cane sets were scarce all over the Province, and therefore ratooning was resorted to on a more than usual scale. This perhaps has something to do with the general prevalence of *Pyrilla* in the year. Experiments to determine the effect of a severe attack of *Pyrilla* on the yield of sugarcane showed that both quality and quantity were definitely affected and ripening was delayed. The study of the relative extent of damage done by sugarcane borer on different varieties of sugarcane was continued and one highly susceptible variety showed damage as high as 90 per cent. In the vicinity

of Gurdaspur sugarcane fields were attacked to the extent of 25 to 30 per cent. By way of control the removal of the damaged central shoot and treatment of the cavity thus created, with petrol spirit or derrisol, resulted in a mortality to the pest varying from 30 to 90 per cent.

MADRAS. Work on this crop is mainly confined to the research stations at Anakapalle, Samalkot and Palur. The chief items under investigation were varieties, manures and methods of manuring, methods of cultivation and rotation. With regard to varietal experiments, an attempt is being made to replace J. 247 at Samalkot; and P. O. J. 2878, the wonder cane of Java, is showing promise. The yields at the station this year are better than the average due, it is believed, to the introduction of a longer rotation and growing the crop on new land free from water-logging. At Palur varietal tests are being continued in garden and wet lands and J. 247 still seems to lead having yielded 946 maunds cane per acre, followed by P. O. J. 2714 giving 887 maunds. The manurial work is mainly directed towards discovering what effect the partial or total substitution of ammonium sulphate for oil-cake has on the crop, and so far it would appear that at all three stations a partial substitution can be made with advantage. From an irrigation experiment conclusions arrived at are that planting early in February is not an advantage and that Co. 213 can be grown with the normal rainfall supplemented by only 4 acre-inches of irrigation at the time of planting. It is found that this variety is more drought-resistant than J. 247.

The rotation experiment on sugarcane at Palur has been continued for 8 years. The yields of cane of the four, three and two-year rotations were 33·74, 29·28 and 24·32 tons per acre, respectively. The outturn of sugarcane in each rotation showed a net profit of Rs. 359, Rs. 280 and Rs. 258, respectively, for all the eight years. The net profits of the several rotations taking all the crops together are, respectively, Rs. 81, 51 and 49. These results show that a wide rotation of sugarcane seems favourable.

BENGAL. Co. 213 has struck the imagination of the cultivator and is spreading rapidly in the districts. Before its advent the

old Tanna, formerly recommended by the department, was grown throughout the province but now Co. 213 is rapidly replacing it in most places. About 10 lakhs of cuttings of Co. 213 were supplied by the departmental farms in each of the two years but a much larger exchange has also taken place between cultivators themselves. Results of recent cutting-out experiments indicate that as a result of the spread of departmental cane, the average yield of *gur* has risen substantially. The next stage is to introduce power-crushing and improved boiling apparatus so as to reduce the cost of production. The Agricultural Engineer has already produced hopeful results in this direction with the help of a grant from the Imperial Council of Agricultural Research. Some new canes show promise, notably P. O. J. 2725, P. O. J. 2714, Co. 245, Co. 270 and Co. 313. As has already been demonstrated at Pusa, October planting appears to have had considerable success in the Brahamputra and Ganges silt areas but in the red soil the result is still doubtful. The Imperial Council of Agricultural Research has granted funds for the establishment of a small cane seedling testing station at Dacca. This station is one of a chain of similar stations in Northern India and valuable results are expected from a comparison of the behaviour of different canes at the respective stations.

ASSAM. Work at Jorhat consisted mainly of the acclimatization of varieties of cane and of cultural and manurial experiments. The following varieties so far have proved most suitable:—P. O. J. 2714, Co. 213 and several others show promise.

BURMA. Gillman and Striped Mauritius have established themselves as the best of the earlier introduced varieties. The Java cane P. O. J. 2878, a new introduction, shows vigorous growth and is a good ratoon cane. It has met with much favour among the cane-growers in the Pyinmana neighbourhood. The superiority of this cane over the local cane may be realized from the fact that the experiments at Pyinmana have proved that it yielded 5·19 tons of sugar per acre against 3·19 of the local variety. The introduction and testing of varieties are being continued. In addition seedling canes are being raised for testing. The effect of fertilizers on the growth of the cane crop is being studied. The

results show a substantial response to the application of nitrogenous fertilizers, the yield per plot of cane having increased with each increase of fertilizer up to a limit. The addition of phosphate to a nitrogenous fertilizer did not give any further increase in the output of cane. An examination of the local pit method of planting and the cheaper method of laying the sets in a furrow shows that there is a marked increase in the output of cane in favour of the pit method. The increased output from this method more than compensates for the economy in the cost of cultivation of the furrow method. Much work is in progress regarding manurial experiments but the results are not yet ready for analysis.

BOMBAY. Much work has been done in Manjri with regard to the testing of varieties but it is difficult to beat the local Pundia. The four thick varieties, *viz.*, Striped Mauritius, Manjav, J. 247 and Red-sport, were the favourites of the ordinary Malbari cane-growers and have now largely replaced Malbari. Of the thin canes Co. 210 and Co. 213 are preferred where there is scarcity of water or where the water is brackish. As a result of the visible effect on the crop by the use of sulphate of ammonia as top-dressing on Amalsad farm, it is largely used in the adjoining tract and in course of time will become the general practice with cane-growers there. Manurial experiments at Kumta farm confirm the conclusion that sulphate of ammonia is not very effective in acidic soils and requires a combination of phosphoric acid. A comprehensive sugarcane research scheme is to be launched in the near future and the site for the research station will be near Lonad on the Nira Right Bank Canal. This is a big scheme having for its main objective the production of cane at a much lower price than has hitherto been prevailing. It is hoped to achieve this goal by producing a more thrifty cane than the existing Pundia which will require less manure and which will occupy the land for a shorter period of time than Pundia.

CENTRAL PROVINCES. The area under this crop shows no sign of extending. Work on cane is at present almost entirely restricted to one or other of the numerous types which have been raised at Coimbatore and subsequently tested out and proved on the

various experimental and demonstration farms of the province, in respect of their yield, quality of *gur* and resistance to disease. They are steadily replacing local canes. The particular Coimbatore cane in popular demand varies slightly from district to district. The Mycologist has had this crop under special observance in respect to the damage done by Agya (*Striga*) and its control. It was found that the application of a 3 per cent. solution of copper sulphate destroyed *Striga* which is parasitic on the roots without damaging the sugarcane. Mosaic disease has apparently but little effect in these provinces.

North-West Frontier Province. Many varieties have been tested at the Tarnab Agricultural Station. Otaheite or the Peshawar Pounda is the best cane on rich and abundantly irrigated land, while Assam Red is considered most suitable where the water-supply is limited and the land not so fertile. Co. 213 is rapidly displacing other thin canes in Hazara and Bannu where, due to milder climatic conditions, ratooning is possible. At Peshawar cane does not ripen well and the cultivator is much behind in the methods of producing sugarcane and manufacture of *gur*. The yield this year ranged from 60·76 maunds to as low as 30·38 maunds per acre. At the Haripur Agricultural Station, Co. 213 has been successful for the last five years and it is hoped that very soon it may become a leading variety. The advantages of the Sultan three-roller mill were demonstrated at Haripur and the cultivators acknowledged it to be better than the two-roller machine. In the Peshawar district the three-roller mill has already displaced the less efficient two-roller one, while at Bannu the two-roller mill is still commonly employed to crush the thin cane which alone is grown there.

5. Jute.

The total area under jute in the three provinces of Bengal, Bihar and Assam during 1929-30 was 3,415,000 acres, a rise of 8 per cent. over the previous year. Towards the end of the year the trade depression began to affect the jute market and there was

a considerable fall in prices. Cultivators had fair warning but in spite of this the area sown in 1930 rose just over three per cent. to 3,531,000 acres. The area grown in Bengal was 88 per cent., in Bihar 7 per cent. and in Assam 5 per cent. The outturn of jute for 1929 was 10 million bales of 400 lbs. which was just a little less than the previous year's crop; and in 1930-31 it was 11·2 million bales. During the first year under review, the season was favourable except in eastern Mymensingh and Tipperah where crop was damaged by floods which did such serious damage in Assam that the crop there was reduced by 35 per cent. Jute is the only crop which the average Bengal cultivator can sell to obtain money for rent, clothes, bullocks and other necessities of life. He spends little in cash in producing the crop. Rent he must pay and he may have to buy seed but he only employs outside labour in years of exceptional prices. It is only when the price of paddy exceeds that of jute that the cultivator can expect to obtain a greater gross return from paddy as an alternative crop. He thus maintains his acreage under jute even when faced with declining prices.

Seed of departmental races D. 154 and Chinsurah Green continued to be sold through the Government Selling Agent, Narayanganj. The Agent disposed of 320,000 lbs. of seed for 1929 sowing. It is estimated that about 9 million acres were sown with departmental races of jute, and as D. 154 gives an average increased yield of 240 lbs. per acre and C. G. 400 lbs. per acre over local races, the increased return to cultivator amounted to over two crores of rupees. The increasing area under Government seed led certain members of the jute trade to attribute the poor quality of the jute coming forward to the use of Government seed, and this question was discussed with the trade in Calcutta. Since 1923 experiments have been conducted in collaboration with the trade to compare the quality of the Government races D. 154 and R. 85 with local races, and a race called Fanduk was selected by the trade as being of the finest quality. These experiments were conducted on Government farms and at the agencies of baling firms throughout the jute-growing tracts in East and North Bengal. The fibre was submitted to assessors selected by the trade both in Calcutta and

Dundee. Over a period of five years the points were distributed in Calcutta as follows :--

D. 154 (Government seed)	R. 85 (Government seed)	Fanduk	Local
74	82	74	49

and the average yields per acre were :—

D. 154	R. 85	Fanduk	Local
1,489 lbs.	1,403 lbs.	1,208 lbs.	1,198 lbs.

It is thus obvious that Government seed is not a factor affecting the deterioration in quality. That deterioration has taken place cannot be denied but it is due to several causes. Improved machinery in the mills enables the consumers to manufacture fibre which, owing to its inferior quality, would not have found a market in the past. With the demand exceeding the supply, any quality is accepted by the mills but when heavy supplies are forthcoming the mills pick and choose and complaints are common. The remedy lies with the trade. If the cultivator obtains sufficient premium, he will devote time and care to producing clean quality fibre. At present he gets paid for stick, bark and root as fibre. With clean fibre he loses the weight and does not get an equivalent enhanced price for his pains. The Agricultural Department has impressed upon cultivators the advisability of clean and careful retting, but this advice will not be readily accepted if the cultivator receives no appreciable premium for clean fibre.

Jute manufacturers in India in 1929-30 embarked on a policy of expansion of production by working 60 hours a week instead of 54 hours in the mills, though at this time there was less movement of trade commodities throughout the world and consequently less demand for gunny bags and hessian. This arrangement resulted in the accumulation of heavy stocks that could not be sold at even much reduced prices. In 1930 the weather conditions were favourable all over the jute area and the result was a bumper crop which really aggravated the depression in the trade which was already serious during the previous year. In April 1929, the

quotation for " Firsts " in Calcutta was Rs. 66 per bale of 400 lbs., but it fell to Rs. 44-8 by March 1930 and to Rs. 28-4 by March 1931. These prices in Calcutta were low indeed but it must be remembered that the growers got much less and at times they could with difficulty dispose of their fibre at Rs. 2 to Rs. 2-8 per maund. It will thus be seen that the course of raw jute prices throughout the period under review was disastrous to all concerned. Fortunately a bumper crop of rice was obtained and as a result of vigorous Government propaganda and financial assistance in the shape of agricultural loans, the area under *rabi* crops was extended and foodstuffs were plentiful and cheap. Government and landlords had to postpone collection of rents, and Government officers were engaged in intensive propaganda advocating the restriction of sowings and the substitution of other crops such as sugarcane for jute. Cultivators, as a rule, are reluctant to reduce sowings in case neighbours do not and score if prices rise. In spite of this, sowings in 1931 were reduced to an estimated area of 1,858,100 acres, 53 per cent. of the area sown in the previous year. Through the Government Selling Agent, 220,000 lbs. of departmental jute seed were sold to cultivators, sufficient to sow 25,000 acres. Natural extension of the area under the improved varieties continued, and it is now difficult, particularly with *Olitorius*, to obtain seed of local races for testing purposes. Cultivators are beginning to appreciate the fact that departmental seed is more remunerative than local seed even in lean years, for they can obtain the same quantity of fibre from a reduced area and keep land for food crops. A cultivator growing $\frac{4}{5}$ths of an acre of local jute receives the same quantity of fibre as a neighbour growing $\frac{3}{5}$ths of an acre of departmental jute, and the latter has an additional $\frac{1}{5}$th acre to put down to paddy.

6. Other fibres.

Hemp. At Pusa eight old types of *Hibiscus cannabinus* and 4 old types of *Hibiscus sabdariffa* were maintained. Several crosses were made and their progeny studied. The new type of the latter, mentioned in the previous Review, thrived well and was

immune to the sclerotial disease which attacked *Cannabinus* types rather severely. Some seed of *Hibiscus sabdariffa* var. *Altissima* a type commonly grown in the Philippines, was received from the Director of Agriculture, Philippines, and produced plants that looked the same as the " new type " isolated at Pusa. Some fibre of this " new type " sent to the Imperial Institute, London, was rather favourably reported on. The fibre was harsher and coarser than jute and of a strength slightly superior to that of Bimlipatam jute. Grown at Dacca and other places in Western Bengal, it seemed to do well and it is intended to give it a thorough trial next season when the quality of the fibre will also be tested.

***Sann-Hemp* (*Crotalaria juncea.*).** Owing to competition with better quality hemp obtainable from other countries, the trade in Indian hemp has been declining considerably. The decline has been due in a large measure to the increased use of hard fibres for the manufacture of twine and cords in preference to Indian hemp. As a general rule, Indian hemp was preferred only when its price was relatively lower than that of other fibres. Despite the favourable crop and lower prices in India in 1929-30, the exports of hemp declined by 22 per cent. both in quantity and value, from 561,000 cwts. valued at Rs. 87·5 lakhs in 1928-29 to 435,000 cwts. valued at Rs. 68·3 lakhs. Again, next year, they fell by 33 per cent. in quantity and 42 per cent. in value, to 293,000 cwts. worth Rs. 39·5 lakhs. With the exception of 1921-22 these were the lowest recorded since the beginning of the century.

As mentioned in the last Review, the Imperial Council of Agricultural Research appointed an officer for seven months to enquire into and report on the condition of the sann-hemp trade, and he visited the most important hemp-growing tracts in India including the United Provinces , Central Provinces, Bihar & Orissa, Bengal and the Bombay and Madras Presidencies. Among the objects of study were the suitability of the various tracts for the production of hemp, the methods of cultivation, retting processes, modes of extraction, preparation of the fibre, baling operations and the existing systems of marketing in up-country production centres. Results of experiments which had been carried out in the various

parts of India were examined and the subject-matter of the enquiry was discussed with all persons and bodies concerned with the growing and handling of the fibre. His report does not claim to be an exhaustive treatise on the subject, but it is hoped that the tentative findings and proposals embodied in it will be helpful in evolving constructive schemes. It will be considered by the Imperial Council of Agricultural Research some time next year.

At the instance of the Advisory Committee on Vegetable Fibres, Imperial Institute, London, experiments on retting to determine the critical period for plants to remain immersed in the retting process were undertaken in Dacca and samples of fibre sent to London for valuation, where they elicited the opinion that $3\frac{3}{4}$-$4\frac{1}{2}$ days' retting at 75-79° F. is the optimum.

In the United Provinces an investigation was made into the possibility of improving sann-hemp by chemical treatment, either by adding small quantities chiefly of ammonium salts or bleaching agents like sulphites, or by chemical treatment of the retted fibre with a view to improve the tensile strength. Some treated and untreated bales were sent to London for report. The selection of sann-hemp made in 1926, known as Cawnpore 12, grows taller than the local varieties and yields more fibre of better quality as regards length, colour and texture. Its seed has been supplied to many centres in India and favourable reports have been received.

In the Central Provinces extensive experiments relating to the effects on the fibre of varying conditions of sowing and retting were conducted on the College Farm, Nagpur, and at Adhartal and Chindwara Farms. Three factors were kept in view: conditions of growth, length of the retting period, and temperature of retting. Three-hundred samples were sent to the Indian Trade Commissioner for valuation and from the reports so far received, it appears that a seed-rate of 60-90 lbs. per acre yields a satisfactory fibre and that the retting period will have to be lengthened during the cold months.

Flax. In BENGAL two exotic races of flax ('Riga' from seed supplied by a firm and pedigree J. W. S. the seed of which was supplied by the Linen Industry Research Association, Lamberg)

were grown at Dacca, Dinajpur, Berhampur, Malda and Rangpur and the straw was sent to the Lamberg Research Association for extraction and valuation. It is reported that the Bengal samples were priced higher than the best Irish marks. The one-year-acclimatized seed was again sown and samples have been sent to Lamberg: the report is awaited. Flax appears to have great possibilities in North Bengal. The difficulty is in the extraction; the technical processes of retting and skutching will have to be undertaken by capitalist or co-operative agencies.

7. Tobacco.

The total area under tobacco was 1,308,000 acres in 1928-29, 1,317,000 acres in 1929-30 and 1,257,000 acres in 1930-31. The total yield of dried leaf was 599,000 tons in 1928-29, 629,000 tons in 1929-30 and 572,000 tons in 1930-31. The bulk of the tobacco grown is consumed in the country but there is a small though valuable export trade, chiefly of unmanufactured leaf, much of which goes to Great Britain because of the custom's rebate of about 2 shillings per pound given to Empire-grown tobacco. In 1928-29, 14,700 tons were exported valued at Rs. 123 lakhs but in the next year there was a marked fall to 11,600 tons valued at Rs. 99 lakhs, the decrease being most noticeable in shipments from Bombay. In 1930-31 the amount went up to 12,900 tons but the value was only Rs. 96 lakhs on account of the fall in price. The establishment of cigar factories in Great Britain, Africa, Australia and New Zealand in order to secure the advantage of the tariff protection, has diverted a large share of the demand for Indian cigars to the home-made articles. Brands of mild quality to compete with the imported Dutch and Manilla cigars have shown an improved demand. There is an import of unmanufactured tobacco chiefly from America for making higher class cigarettes and for cigar wrappers and pipe tobacco. In 1928-29 the quantity was 5,350 tons valued at Rs. 274 lakhs. Next year there was a fall of 15 per cent. in quantity to 4,520 tons valued at Rs. 270 lakhs. There is little doubt that the high duties imposed in March 1927 served as a handicap to the continued expansion of this trade. Again in

1930-31 imports fell by 51 per cent. to 2,200 tons valued at Rs. 151 lakhs. This unprecedented fall was chiefly in the import of unmanufactured tobacco due to the boycott of cigarettes all over India, though the economic depression had also something to do with it.

At PUSA, during the period under review, further experiments in flue-curing were carried out. The new hybrid No. 177 maintained its quality and yields of about 1,000 lb. dry cured leaf per acre were obtained with this type. With the object of improving the quality of an indigenous tobacco to suit cigarette manufacture, a local Type 28 was crossed with an American Adcock in the year 1924. This has resulted in evolving ten hybrids which have now become fixed in their characters and are breeding pure within narrow limits like the original parents. Several other crosses are at various stages of examination. Attempts have been made to grow tobacco in Bihar in the rains, sowing and transplanting being done about three months earlier than normal. While the scale on which this has been tried is so far limited, the experience gained indicates that the incidence of leaf-spot and leaf-curl diseases are likely to prove the limiting factors for the cultivation of tobacco in the rains in Bihar. Hybrids 142,164 and one of the indigenous types (Type 49) were grown and flue-cured. Hybrid 142 yellowed very quickly in the barn and also gave a percentage of yellow leaves which was much higher than in the case of other hybrids hitherto tried. Hybrid 164 also cured fairly well but it was lower in quality and yield to hybrid 142. Type 49 could not be cured to a bright yellow colour, and this further confirms that none of the indigenous types are much good for flue-curing. A sample of flue-cured leaf of Type 177 was tested by the Indian Leaf Tobacco Development Co. and reported as equal to leaf valued at As. 8 per lb. Besides hybrid 177, other hybrids tried were 192 and 196. Both these are heavy yielders but they are late and all their leaves do not ripen uniformly and quickly, hence they have not proved superior to hybrid 177.

On a commercial scale there has been a great increase in flue curing in India and this method has now almost entirely supplan-

ted the old rack-curing method in the production of cigarette tobacco. With the establishment of flue-curing on a large commercial scale we may consider that a definite stage has been reached in the tobacco researches commenced at Pusa in 1924.

In the MADRAS PRESIDENCY tobacco is grown in two tracts—one in Guntur and the other in Trichinopoly. In the former tract several exotic varieties introduced for cigarette-making by tobacco firms were extensively grown and flue-curing was taken up on a large scale but, in the latter year under review, the firms had to close their branches with disastrous results to the growers, as the flue-cured leaf was not suitable for local consumption and unsaleable. Work on the local varieties is required at the Research Station, Guntur, but no systematic work with regard to selecting varieties, methods of cultivation and curing has yet been started. In the Trichinopoly tract two promising varieties, Pusa 28 and Havenna were found to be superior to the local tobacco and have sold at a substantial premium.

At the Tobacco Station at Nadiad in BOMBAY two strains No. 6 and No. 28 proved definitely superior in three years trials and seed is being distributed. A large number of selections made from the local crops and several crosses are being studied for their economic characters. To test the general belief that the smoking character of tobacco bears some relation to the number of leaves left on the stem at the time of nipping, an experiment has been carried out for four years leaving from 10 to 20 leaves, but the results from year to year are not uniform.

In BENGAL, though heavy rain delayed transplanting and hail did some damage, the seasons were favourable and the crops good. Still the experience of both seasons indicated that seedlings should be transplanted as early as possible, as a difference of a fortnight at this time made a great difference in growth and yield. Though the main work on tobacco was done in the Government Tobacco Farm, Rangpur, yet several other farms were also engaged in it chiefly in producing seed and seedlings for distribution to surrounding growers. Over 5 lakhs of seedlings were distributed each year and about 1,730 tolas of seed. So great has been the demand that

arrangements have been made on selected farms to grow seed and seedlings under departmental supervision. Several exotic varieties were grown and great care was taken to instruct and help cultivators with the crop. The main varieties were Motihari, Bhengi, Pennsylvania, Sumatra, Manilla II, Vuelta, several American varieties like Ohio, Orinoco Yellow Prior, Hickory Prior. White Burley and Warne were under trial as well as two Turkish varieties Aysolouk and Cavalla. In several districts these exotic tobaccos have been grown by the cultivators and the results showed that the production of high-grade cigar tobaccos in Bengal is more than a possibility and that with reasonable care the province can produce cigar-leaf capable of taking its place in the world's market.

Most of the tobacco of BURMA is grown on land annually enriched by deposits of silt from the flood waters of the big rivers. Thus it requires no manuring, yet the average yield is from 800 to 1,000 lbs. of dry leaf per acre. Experiments at the Sa-aing Farm, which comprises 10½ acres worked as an annexe of the Allanmyo farm, were continued. Eight varieties of tobacco were under trial and the curing of these was carried out in ventilation-controlled barns of the Bengal type. All the tobaccos cured are of fairly good colour but the prominent veining of the leaves of Burmese Havana, Sumatra and Pusa 28 is against their popularity. Cheroot-rolling was continued as in previous years, using only the tobacco which has matured for two seasons. Cheroots made with Manilla tobacco for filler and Pennsylvania for wrapper are best liked. A slight alteration in the design of the curing barns has been made; the Bengal type, found to be costly, was lowered by one tier. The Deputy Director is doubtful if these or any other type of curing barns are satisfactory. For experimental work in tobacco-curing what is required is a barn for flue-curing but this will have to await the provision of the necessary finances. In the meantime work will continue mainly with a view to the production of a superior type of cheroot.

Tobacco is an important crop in NORTH BIHAR and its cultivation is very carefully done by a special class. Pusa 28, a selection from a North Bihar tobacco, is a heavy yielder and much sought

after by the *mahajans*. At Sabour, comparative yield-trials in, 1930-31 showed that the selection Pusa 28 gave a better yield under irrigation than the hybrid Pusa 117 but work will be continued as the latter has the asset of being a good chewing tobacco, so that when the cigarette manufacturers do not purchase it, there is still a local market.

8. Oil-seeds.

The estimated area and yield of the principal oil-seeds in 1929-30 and 1930-31 as compared with 1928-29 are shown in the following table :—

	1928-29		1929-30		1930-31	
	Area in thousands of acres	Yield in thousands of tons	Area in thousands of acres	Yield in thousands of tons	Area in thousands of acres	Yield in thousands of tons
Rape and Mustard .	7,038	910	5,907	1,095	6,586	991
Linseed . . .	3,109	322	2,802	380	3,020	378
Sesamum . .	5,543	495	5,346	455	5,564	526
Groundnuts . .	6,351	3,211	5,748	2,668	6,366	3,108
Castor . . .	1,410	113	1,285	116	1,452	118
Cotton-seed . .	..	2,100	..	1,918	..	1,777
TOTAL .	23,451	7,151	21,088	6,632	22,988	6,898

In 1929 the production of cotton was 5,285,641 bales and the output of cotton-seed calculated at ·36 of a ton per bale may be estimated at 1,910,000 tons. Similarly, in the succeeding year 4,912,000 bales would correspond to 1,777,000 tons of cotton-seed A considerable change has occurred during and since the war in India's export trade in oil-seeds. Local consumption, which is steadily on the increase, has been able to outbid a weak foreign demand. Only with regard to linseed is the export demand trying to overtake the previous level. In copra, for instance, India's exports averaged 31,000 tons annually in the pre-war period but in 1926-27 they dwindled to 2,000 tons and now have practically disappeared. In linseed, cotton-seed, rapeseed and sesamum there has also been a substantial reduction in India's exportable surplus compared with the pre-war figures. But in the case of

groundnuts internal consumption has not yet overtaken the increased production resulting from extended cultivation, with the result that much larger quantities are available for export. The table below shows the quantities of the principal kinds of seeds exported during the last three years and in the pre-war quinquennium :—

	Thousands of tons			
	Pre-war average	1928-29	1929-30	1930-31
Linseed	379	157	248	257
Rapeseed	273	77	44	33
Groundnuts	212	788	714	601
Castor	114	121	106	91
Cotton	240	131	58	41
Sesamum	119	30	11	1
Copra	31	..	..	..
Others	85	24	14	13
TOTAL	1,453	1,328	1,195	1,037

The exports of vegetable oils and oil-cakes have also been declining as will be seen in the following table :—

	1928-29	1929-30	1930-31
Vegetable oil in gallons	1,586,000	1,348,000	1,140,000
Oil-cake in tons	328,000	273,000	254,000

Rape and Mustard. The United Provinces has half the acreage of these crops in India, the other important provinces being the Punjab (1,000,000 acres), Bengal (750,000 acres), Bihar and Orissa (700,000 acres) and Assam (350,000 acres). Only a small quantity of these crops was exported.

At PUSA, a number of samples were collected from all over India in 1929-30 for investigation and isolation of types. The information regarding the scientific and vernacular names of these species in the Indian works on Botany is very confusing. The best available record is found in Prain's valuable article, " Mustards cultivated in Bengal," published in the Agricultural Ledger No. 1 of 1898, which of course deals with only one province. A tenta-

tive classification of the species and sub-species has been made. All the samples have been grouped into nine species, out of which only three are self-fertile. The work of isolation of types has been taken up in these species and will be completed soon. The remaining six species, which are self-sterile, form a good material for investigation of the sterility problem, and various experiments in this direction have been undertaken. In the PUNJAB, BIHAR and ORISSA and ASSAM the isolation of pure lines was also in progress and breeding work was attempted. In the meantime mass-selection and drill-sowing have been found to increase yields.

Linseed. The area under linseed is about 3 million acres, chiefly in the United Provinces (955,000 acres), Central Provinces and Berar (806,000 acres) and Bihar and Orissa (806,000 acres), the acreages being given for 1930-31. The linseed crop of 1929-30 was 18 per cent. better than in the preceding year, being estimated at 380,000 tons. Next year it was 378,000 tons. At PUSA the various pure types were maintained and 32 types of linseed and flax were received from New South Wales for comparison. The genetic results of the crosses made between Types 12 and 121, the two best small-seeded types of Northern India, and several of the bold-seeded types of peninsular India were published in 1931. The most promising types among the hybrids have been tested for yield and oil-content. The study of the inheritance of characters has thrown light on some very important points.

In the UNITED PROVINCES, tests have shown that certain cross-bred strains are better and more disease-resistant than the best local selections.

In the CENTRAL PROVINCES, the selection known as E. B. 3 is the best for Berar and the Nagpur and Chhattisgarh divisions, but the Pusa varieties so far tested have proved to be unsuitable for the conditions obtaining in these provinces. Hybridization between a local type and Irish flax which is very rust-resistant has given promising results.

Cultivation of linseed is tending to increase in Orissa. Of the three types, Pusa 12, 121 and Sabour 6 under trial, those from Pusa were found to be better yielders but the Sabour type, on

account of its wilt-resistance, excelled the Pusa types in years when wilt was severe. Hybridization with a view to unite those characters is in progress.

In BENGAL, a survey of the local types has been completed. Some local selections have been found to be superior to the Pusa types because the latter are not early-maturing enough to suit conditions in Bengal.

Sesamum. Sesamum is largely used for local consumption for edible purposes, etc., and its export has declined to insignificance. At PUSA an account of the unit species and a study of the growth of sesamum in different soil conditions with special reference to root development was published, while a study is now being made of the inheritance of characters. Sesamum is an important crop in the dry zone of UPPER BURMA but is liable to be destroyed by excessive drought or excessive rainfall. Work with early and late strains was continued by the Economic Botanist at Mandalay. Some gave promising results and six were multiplied for distribution. One of them that showed marked immunity to green flower and wilt has become very popular and the department is, on account of this success, succeeding better with its demonstration of line-sowing.

Groundnut. The four chief areas in which this crop is grown are Madras with 3·5 million acres, Bombay with 1·5 million acres, Burma and Hyderabad State each with half a million acres. The production of groundnuts in 1929-30 was estimated at 2,668,000 tons or 17 per cent. less than the previous season's record figure, while the crop of 1930-31 was 3,108,000 tons. Exports consisting largely of decorticated nuts constituted a record at 788,000 tons in 1928-29 but declined to 714,000 tons in 1929-30 and further to 601,000 tons in 1930-31.

In MADRAS, an Oil-seeds Specialist was appointed and he has been busily engaged in organising the various investigations and in growing and studying different varieties of this crop. In BOMBAY, the strain No. 5 of Spanish Peanut continued to find favour and 29,000 lbs. of seed were distributed in 1929-30 and 38,000 lbs. in

1930-31. Experiments showed that a groundnut-*jowar* rotation gave better results than tobacco-*jowar* or cotton-*jowar*, and that groundnut and *jowar* in alternate rows gave better results than either in blocks with *jowar* in the rotation and the intention is to follow up this line of work. An agricultural survey of this crop in BURMA was completed and published. Groundnut is grown chiefly in the dry tracts mainly in rotation with sesamum, the yield of which is materially increased thereby, but in the riverine tracts a short-season erect type of Spanish groundnut was reported to be extending rapidly. For a number of years trials have been going on at various centres with a view to single out varieties with high outturn and maximum oil-content and to decide the best spacing. Four spreading and two erect types have been chosen as good performers. In HYDERABAD, Kanki 17, a variety from Bihar, gave good promise and was multiplied at almost all the farms for distribution to cultivators. Groudnut cultivation is extending rapidly in BERAR as a rotation crop with cotton and plays an important part in the agricultural economy of these tracts. The two varieties which are in commonest demand are Small Japan and Spanish Peanut. The latter is a high yielder, with a better percentage of oil, but on account of being prone to easy germination in the field, is suitable only for areas where later rains are not common. A new variety known as Akola 10 has passed the experimental stage and has been found to be a better yielder than the Small Japan and Spanish Peanut. This variety is being widely distributed for further trials. Two factors are retarding the spread of groundnut, the cost of lifting and scarcity of labour during harvesting. A special form of plough, used at the Akola farm, ploughs the soil and simultaneously brings the crop to the surface, and this effects a saving of Rs. 5 per acre. Regular markets have been established in Berar for the disposal of this crop, where nearly 100,372 acres are under groundnut cultivation and number of oil-mills have also sprung up. The department maintained 1,814 and 2,099 private seed-farms for this crop during 1929-30 and 1930-31, the total amount of seed distributed being 57,653 and 59,636 maunds in the respective years.

The Chota Nagpur and Orissa Feudatory States in BIHAR AND ORISSA offer a suitable field for the cultivation of this crop, the two obstacles in the way of its spread being the cost of harvesting and damage done by jackals. Both these difficulties could be met by having an early harvest, and the problem is being investigated at the Kanke farm from three points of view: the use of phosphatic manures to induce early ripening, substituting an early-maturing variety and early pre-monsoon sowing.

In MYSORE, a number of varieties from all parts of the world were under trial. Hybridization work has progressed and the hybrids are being tried in the districts. A recent importation, Valencia, appeared very promising. It has been found that liming and manuring increase the yield to a marked extent and there is a better development of the shell also.

Castor. Rather more than half the area under castor is in HYDERABAD STATE and about 20 per cent. in Madras. In that State individual plant selections have been made which are superior both in yield and in oil-content. A comprehensive scheme for plant-breeding of castor was submitted to the Imperial Council of Agricultural Research.

In BOMBAY, the commercial varieties were classified botanically and selections made from pure lines, nine of which were tested at Poona and Nadiad. Work along this line is to be continued at Prantij in the heart of the castor-growing tract. Similar work was done in the UNITED PROVINCES.

Coconut. In Madras work was continued on manurial, varietal, distance and depth-of-planting trials at Pilicode; on the effect of cattle manures, fish guano and ashes in different quantities at Nileshwar; on the study of the characters of units from different coconut-growing centres of the world and crossing and selfing at Nileshwar; and on manurial requirements and cultural problems at Kasargod. On account of the efforts of the department, large areas of dry land have been brought under coconut cultivation, and there is a keen demand for seednuts and seedlings. In addition to the nurseries maintained by the department, there were 16 private nurseries under the guidance of demonstrators. 34,539

seedlings and 890 seednuts in 1929-30 and 20,905 seedlings and 3,735 seednuts in 1930-31 were distributed to the ryots. Plots where proper planting, manuring and methods of inter-cultivation were demonstrated numbered 688 in 1930-31. *Nephantis serinopa* is a serious pest in the West Coast but the control measures of cutting and burning infested leaves and liberating parasites have had considerable effect in reducing its ravages both in Madras and in Travancore.

Through the efforts of the Department of Agriculture in TRAVANCORE STATE the area under coconuts is gradually extending. Economic work was carried on at four stations. Varietal, cultural, spacing and manurial experiments were carried out with a view to getting the most suitable data for the various types of soil. At the Akyab Agricultural Station in BURMA, in the manurial and cultural schemes laid down 4 years ago, 45 per cent. of the trees began to bear in the treated blocks against 10 per cent. in the untreated blocks.

Tung Oil. The tung oil trees *Aleurites fordii* and *A. montana* are quick-growing, medium-sized trees, the fruit of which produces china wood oil that, on account of its rapid drying property, is valuable in the manufacture of paints and varnishes, particularly motor-car varnishes. They were introduced into BURMA in 1929 from seed obtained from Hankow in China. Planted in small areas at Maymyo, Mandalay and Hmawbi the seeds germinated well and so far the plants have grown well. Cultivation on a larger scale on about 720 acres was undertaken by private enterprise in the Northern Shan States and the trees have come on so well that extension of the area to double that acreage is contemplated. The Agricultural Chemist, Burma, examined a number of soils on which it was proposed to grow tung and, as at the present time the only definite information regarding soils on which tung grows is to the effect that it prefers an acid soil, the investigation was limited to this point. In the result it would appear that many soils in the Shan States are suitable.

The services of the Royal Botanic Gardens at Kew have been given to securing its wider distribution in the Empire and through

the Royal Botanic Gardens, Calcutta, a good many estates in India especially in the tea-growing districts have undertaken to experiment with it on various soils and at different elevations. Besides these, trial plots have been laid down near Ranchi in Bihar and Orissa and at three elevations on the southern slopes of the Nilgiris. The growing of tung in India is yet in the experimental stage and, though it holds out distinct promise, it has still to be established that planting on a commercial scale will be remunerative.

African oil palm. At the Mudon Agricultural Station, BURMA, the African oil palm showed vigorous growth and flowered in the fourth year. The plant for the extraction of palm oil arrived but had not been worked before the end of the period under review.

9. Tea.

Tea is grown in three main areas in the Brahmaputra and Surma valleys of Assam, in the Darjeeling and Jalpaiguri districts of Bengal and in South India, chiefly in the Mysore and Travancore States and the Nilgiris, Wyanad and Coimbatore districts of Madras Presidency.

The total area under tea in India was 756,000 acres in 1927, 775,900 acres in 1928, 788,000 acres in 1929 and 805,800 acres in 1930, showing a small but steady increase from year to year, and of this area approximately 90 per cent. was plucked. The total production of tea was 391 million lbs. in 1927, 404 million lbs. in 1928, 433 million lbs. in 1929 and 391 million lbs. in 1930. The production for 1929 was a record figure.

The year 1929 was exceptionally favourable to the production of tea. The favourable climatic conditions prevailing throughout the year supplemented by an absence of blight led to record crops. The continued policy of manuring helped by a better supply of labour tended also in the same direction. The general standard of quality in 1929 was not altogether good but could be described as useful. As usual Assam contributed the largest share, *viz.*, 259 million lbs. or 60 per cent. of the total output while Northern India, excluding Assam, contributed 116 million lbs. or 27 per cent.,

and Southern India 58 million lbs. or 13 per cent. The production in Assam increased by 13 million lbs. whereas that in the rest of Northern India increased by 15 million lbs. and in Southern India by half a million lbs. The outstanding feature of the tea trade this year was a serious drop in prices, which at certain stages of the season were definitely below the cost of production. The average price per pound for the season in the tea auctions in Calcutta was 9 as. 4 ps. as compared with 11 as. 4 ps. in 1928-29 and 14 as. 10 ps. in 1927-28. This remarkable fall in prices was not, however, justified by the quality of the season's crop, for the general standard was not very much below average. The chief explanation lies in the over-production of tea in all the tea-producing countries of the world.

The year 1930 was not so favourable for the production of tea as the previous year. Drought and hail-storms in the early part of the year, unusually heavy rain in June and again in August and cool wet weather in autumn caused a great decline in outturn. In spite of the unfavourable weather conditions, the general standard of quality may be described as good average. Assam contributed 233 million lbs. or 60 per cent., the rest of Northern India 102 million or 26 per cent. and South India 56 million or 14 per cent. Production in Assam decreased by 26 million lbs., in the rest of Northern India by 13 million lbs. and in South India by 3 million lbs. This great decrease was due partly to the unfavourable weather during the season and partly to the operations of the agreement to restrict the output of tea in the chief tea-producing countries, India, Ceylon, Java and Sumatra. The average price of tea per pound realised at the Calcutta auction sales during the season was 9 as. 4 ps., being 7 ps. lower than the average for the previous year. On the whole, however, the tea industry was not depressed to the same extent as most other industries, the chief cause for which was the healthier outlook created by the restriction agreement reached about the middle of April, 1930.

At Tocklai the Scientific Department of the Indian Tea Association continued the investigation of tea problems both from the agricultural and manufacturing points of view. The work on the

chemistry of the tea-leaf was concerned mainly with the extraction, preparation and estimation of tannin in the tea-leaf, with the effect of manuring on the tannin-content, with the oxidation and condensation products of tea-tannin and with the changes in tea-tannin observed to take place during the manufacture of tea. A preliminary investigation on the pharmacology of tea was undertaken. In the first year of the experiment manuring with nitrogen, potash and phosphate, alone or in combination, has no significant effect on the tannin-content of the leaf, and no significant change in potash or phosphoric acid content of the leaf that is used for tea making. These results do not support the theory that manuring has any great effect on quality. The work on manures will be discussed further in Chapter III.

The observations made in 1930-31 on the starch reserves on plucked bushes confirmed those made in previous years, *i.e.*, that a period of rapid growth is usually accompanied by a fall in starch reserves while a period of slow growth is usually associated with an accumulation of starch. On unplucked bushes the same observations were made but, in addition, there was some indication that a temporary fall in starch occurred during the filling of the seeds. The removal of mature leaves of bushes from the beginning of July to the end of the season caused a drop in the reserve starch content, and this fact makes it easier to understand why black rot and other diseases which reduce the area of mature leaves on a bush may cause serious loss in crop. The results of plucking individual bushes of both dark and light-leafed types clearly showed that the highest yielding bushes were producing at least 70 per cent. more crop than the average of the bushes concerned. This increase appeared to be due to the greater number of shoots plucked and not to the increase in size of the individual shoots.

It has been established that tea can be propagated by green shoot cuttings and further progress was made with this work during the year, but it is too early to draw any particular attention to this as it will be first necessary to grow the bushes to maturity. It is of interest to note that Russian scientists have repeated the experiment with successful results. They claim to have obtained

73 per cent. of successes. The investigation on the flowering and fruiting of bushes was continued.

The influence of bacterial control in relation to tea manufacture was established during the period under review and some of the effects of bacteria determined. It was shown that bacterial infection can take place at any stage of manufacture, the result depending on the species of organisms concerned, the intensity of the infection and probably the temperature of the factory. Evidence also pointed to the fact that the virulence of any particular species may vary according to its condition of growth. With this knowledge it has been found possible to account for various defects in tea manufacture and to devise measures for their elimination.

On the agricultural side, work was done on trials of different varieties of tea, pruning, skiffing, plucking, cultivation and manuring. It has been suggested in some quarters, that labour and other difficulties might be minimised by inducing the tea bush to flush during the cold weather when bushes under normal treatment are dormant. The two factors which might prove effective in producing cold weather crop are manuring and pruning. Previous trials have proved the inefficacy of late manuring. Whenever the manure be applied, bushes close up at the same time. Heavy manuring does lengthen the season at both ends a little but the crop in the cold weather months is still inconsiderable. In some years a fair December crop can be taken, though generally the delay in pruning necessary to take it would lead to losses of greater amount in the following season. There is no hope of obtaining crop in paying quantity during January and February in the climate of Assam. Districts of North-East India which remain warmer and have a longer period of daylight would make a little more tea in the cold weather, but hardly in quantities likely to pay for plucking and manufacture. As against annually pruned tea which yields very little in March, April and May, unpruned tea will yield quite well in these months. The use of some unpruned tea to yield in March, April and May is the only practicable method of lengthening the plucking season in North-East India, and this

practice is attended by the disadvantage that having to cut two years' old wood entailed by the use of unpruned tea causes larger and less easily healed wounds which tend to deterioration of the frames of the bushes.

All results were in accord with the natural assumption that crop depends directly on the food-supply to the bush. Manuring experiments showed that crop-increase is proportional to the quantity of nitrogen supplied, up to a very high limit, and that in comparison with nitrogen other food substances make extraordinarily little difference. Even in a rich soil the nitrogen naturally present is insoluble in water and therefore unavailable. It is rendered available by conversion to ammonia and nitrates by soil bacteria. It has been shown that plant roots excrete substances toxic to nitrifying bacteria. The presence of weeds therefore hinders the supply of available nitrogen. Among heavy thatch grass, for example, nitrates can hardly be detected at all, while at the same time nitrates may be in quite high concentration in similar soil when clean. Tea among jungle is therefore starved. The nitrogen rendered available by cultivation is produced at the expense of the soil's reserve of insoluble nitrogen (old plant residues), and cultivation by producing a good supply of soluble food must cause an increased rate of deterioration of the soil. Good cultivation alone, therefore, cannot maintain good crops of tea over long periods. Hence in experiments it was observed that the more poorly cultivated plots were increasing in yield relatively to the better cultivated.

For example :—

Yields in maunds tea per acre.

——	1926	1927	1928	1929	1930	1931
11 light hoeings .	11·70	11·76	12·30	14·94	14·60	15·59
6 „ „ . .	10·17	11·78	12·21	15·00	14·60	15·82
4 „ „ . .	6·36	8·42	8·63	11·17	10·78	13·69
Sickling only . .	3·67	5·27	4·83	5·46	6·04	7·72

In 1926, eleven light hoeings were still yielding more than six light hoeings but thereafter yields have been about equal. Since the tea began to give good cover, 6 light hoeings have kept the land as clean as have eleven light hoeings, so that if suppression of jungle were the main object of cultivation, this result would be expected. Four light hoeings, however, given as they are at 60 days' interval, still allowed very considerable jungle growth, so that it was more surprising to find this plot giving 54 per cent. of the crop from eleven light hoeings in 1926, and 87 per cent. in 1931. Similarly, the crop from sickling only rises from 31 per cent. to 50 per cent. in 1931. In this last case the bushes were still too small to provide much cover, except in patches where a few good bushes growing together have kept down jungle. Presumably the more poorly cultivated plots have maintained the better soil.

Taking all the results on the various blocks in the station together, it appeared to be quite clear that suppression of weeds is the chief function of cultivation; that any system of cultivation which fails to achieve this object is inefficient; and that (at least in comparison with jungle suppression) soil stirring is of little importance. Similarly it has been shown that the effects of cultivation can be secured without actual work with hoes, by supplying the necessary soluble nitrogen as manure in place of rendering available through cultivation the soil's reserve of nitrogen.

At DEVARSHOLA in the Wynaad, the Scientific department of the United Planters' Association of Southern India investigated similar problems applicable to the southern area, *e.g.*, pruning, skiffing, manuring, application of sulphur to increase the acidity on soils where this is necessary to get a better growth of the bushes. Much time was devoted to the chemical investigation of tannin in tea-leaf and in made tea. Further samples of the theo-tannin have been prepared; the analyses of these samples have indicated the necessity for modifying previous conceptions of theo-tannin. Various derivatives, bearing in mind the technological perspective, have been prepared and investigated. Temporary concepts of the constitution of theo-tannin have had to be modified. Work done on made tea has not led to such conclusive results as is the

case with green leaf investigations, but even so the results obtained are enlightening, although no complete explanation of them is at present possible. This work has shown that the oxidation theories of the fermentation of tea are somewhat exaggerated representations of the true facts. The amount of oxidation taking place during this process is, indeed, very small and cannot explain the production of the colour of fermented leaf and tea infusions. A limited amount of oxidation takes place, but the major cause of the obvious changes during manufacture will more probably be found to be a result of hydrolysis. It also appears that pectins are far more important in their bearing on the characteristics of tea infusions than has been suspected in the past. It has been established that, within limits, the proportion of oxidisable true non-tannins in green leaf is approximately constant and there is strong evidence that by using the iodimetric method a single estimation of the total oxidisable value can be utilized to give a close approximation to the true tannin value without performing the precipitation of tannin, which is not only tedious but a mine of possible inaccuracies dependent on small variation in technique. It has been found convenient to study the seasonal variation of the tannin-content of green leaf at the same time. Comparative analyses by the iodimetric and formalin methods were carried out on a large number of ' made teas '. Bulk samples and grades from a number of estates were investigated. Teas from individual estates showed marked similarities between themselves, but significant differences were found between the South Indian teas at present investigated and Ceylon teas similarly analysed. The investigation is being continued as rapidly as possible and, when the analyses have been completed, definite explanatory hypotheses can be adduced.

10. Coffee.

The cultivation of coffee is mainly confined to Southern India in the hilly tracts of the Madras Presidency, Coorg and the States of Mysore, Travancore and Cochin. The total area under coffee remained fairly constant, being 160,667 acres in 1928-29, 163,516

acres in 1929-30 and 160,852 acres in 1930-31. The figures are, however, not strictly accurate in that estates or holdings of less than ten acres do not furnish returns and accordingly are not taken into account in compiling the statistics. In the last year under review, Mysore had 51 per cent. of the total area, Madras 24 per cent., Coorg 23 per cent. and Cochin and Travancore together 2 per cent. The total production of cured coffee amounted to 247,938 cwts. in 1928-29 or 3,500 cwts. below that of the previous year, 352,000 cwts. in 1929-30 and 294,437 cwts. in 1930-31.

The exports during 1929-30 declined by 7 per cent. in quantity from 198,000 cwts. to 184,000 cwts.; and by 14 per cent. in value from Rs. 169 lakhs to Rs. 145 lakhs. The demand for Indian coffee in the markets abroad during 1930-31 was very satisfactory and exports increased to 293,000 cwts. valued at Rs. 192 lakhs, representing an increase of 59 per cent. in quantity and 32 per cent. in value.

At the Coffee Experimental Station at Balehonnur in MYSORE STATE, an effort was made to get growing in the State all the commercially important species and varieties of coffee which might be of any use in breeding work. Selections were made and a considerable amount of hybridizing was done. The first definite cross between *C. arabica* and *C. robusta* produced in India has been planted out. The main object of this work is to produce a variety with the quality for which Mysore coffee is famous and resistance against leaf-disease and 'die-back'. In addition, work is being energetically carried on with the hope of immediate benefit on manuring, on the investigation of fungus diseases and insect pests and trials of fungicides and insecticides, and on grafting of scions from selected bushes on to disease-resistant root-stocks. The first two items of work have already begun to yield results of great practical value and as regards the last item distinct progress has been made.

11. Rubber.

Hevea braziliensis, the rubber tree, is grown in the hinterland along the Malabar Coast of South India and in Southern Burma.

The total area under rubber was 167,000 acres in 1928, 170,900 acres in 1929 and 172,000 acres in 1930. In the last year the relative acreage in the two rubber-growing areas was 55 and 45 per cent., respectively. The area tapped was 112,177 in 1929 and 104,283 in 1930. The decline in yield was due to the intentional reduction of the area tapped. During the period under review, the rubber trade was passing through one of the worst slumps it ever experienced. Over-production for some years past in almost all producing countries of the world contributed materially to bring about this situation, and large exports from the East, in consequence of the release of many tons of rubber after the period of restriction, had the effect of increasing stocks and bringing down prices. The export of raw rubber from India in 1928-29 was 11,527 tons; next year it was almost the same at 11,506 tons, while in 1930-31 it fell to 10,414 tons. In May 1929 the price of ribbed smoked sheet in London was $11\frac{15}{16}d.$ per lb. but it fell to $7\frac{5}{8}d.$ in March 1930. Next year it fell almost continuously to $3\frac{13}{16}d.$ in March 1931. Thus the value of the exports from India has fallen tremendously from Rs. 200 lakhs in 1928-29 to Rs. 179 lakhs and then to Rs. 130 lakhs in the two years under review.

At the Rubber Research Station at Aneikulam in TRAVANCORE, a block of 87 acres has been sprayed annually for the last five seasons with Bordeaux mixture to prevent the damage done by *Phytophthora medii*. It is claimed that the experiment has been successful both from the healthy appearance of the trees—the block appearing as a green island in the country-side during the period of second leaf-fall—and from the increased yields. Spraying was fairly extensive throughout the rubber-growing area, especially on nurseries and young plantations. The application of a disinfectant mixture has effectively controlled bark-rot. Much attention has been paid to experiments on budding from high-yielding trees and to the possibility of discovering at the nursery stage which are the plants that will give a high yield at a later stage of growth. Recently an examination of rainfall and crop distribution has been made and the data collected suggest that a study of cultural operations suited to the irregular distribution

of South Indian rainfall may yield useful results at no very distant date. This, while probably never assuming quite the same importance as the raising of higher-yielding strains of trees, may go far to reduce the average cost of cultivation.

12. Fruit.

This crop, from the economic aspect far less important than the food and money crops of India, has for this reason received less attention and less financial aid in the research connected with its problems than has been its due. Now, however, the necessity for fresh fruit in human diet having been established and more widely recognised, new interest has been awakened in the potentialities of the fruit gardens and orchards of the country, the immediate result of which has been the appointment of fruit experts in various agricultural departments in the provinces. Their activities, if encouraged, should in the near future lead to useful improvement in the supply of good quality fruit not only for use in the home market but for increasing profitable export abroad.

The climatic conditions of the NORTH-WEST FRONTIER PROVINCE are pre-eminently favourable for fruit-growing. In the lower valleys the peach, plum, apricot, pear, grape, pomegranate and quince flourish and in some places the orange and lemon do well. In the markets of Northern India the demand is good and the railway is encouraging the trade. After twenty years of experiment the orchard practice at Tarnab is said now to be practically that which is customarily carried out in the progressive commercial orchards of the world and the aim of the department has been to establish fruit-growing in orchards on a commercial scale where the trees can be properly cared for and effectively protected against diseases and insect pests. The leading varieties are those which are grown in the great orchards of California, South Africa and Australia and the practice in planting, intercultivation, manuring, irrigating, spraying, pruning, picking and so forth is similar to that carried out in the countries mentioned. The yield per acre and the quality of the fruit are not inferior. This year 200 lbs. of peaches per tree were picked. Only the Japan-hybrid or Burbank varieties of

plum bear freely at Peshawar. The European plum does not bear fruit. On the other hand, the Japan-hybrid usually has more fruit than the unsupported branches can safely carry. In the Peshawar valley some trees bear as much as 500 lbs. of good fruit. Although the price per maund of plums is always less than for peaches, the crop is heavier, the trees do not need spraying, pruning is less expensive, the packing charges are light. On the whole plums are fully as profitable as peaches. The earliest variety of value ripens about the middle of May, the latest towards the end of August. The demand markedly declines when the best peaches come in early in July. All the world over, the apricot is notoriously inconstant in bearing fruit. On the average the crop is good at Tarnab only in alternate years. Being cheaply grown and much appreciated in the markets, a fair profit per acre per annum is gained. Thus far one variety only yields satisfactorily, but further trials of several promising kinds are being made. The apricot kernel grub (*Eurytomid Sp.*) which has practically destroyed the once valuable Hazara trade in this fruit has not yet reached Peshawar. Parts of the Kohat district, the Kurram and other elevated valleys are suitable for this fruit. During the recent visitation locusts appeared to like the apricot far more than any other fruit. The Peshawar " Batang " pear has long been appreciated in India's markets, and large quantities are exported in September, October and November. Although the orchards have considerably extended in the past few years, the demand still is good. A new pear named Le Conte, a hybrid between the Batang and the most popular of all market varieties, the Bartlett, which was freely distributed after due trial about ten years ago, is now bearing well in many orchards. Soon it will be as popular as the Batang and it certainly is not less profitable. The Keiffer is another late keeping hybrid that will be valuable when the growers are willing to store the fruit until it is ripe enough for marketing. Because the grapevine is afflicted by the leaf hopper (*Jassid Sp.*) grapes cannot be grown in the Peshawar Khalsa, excepting on fairly high trellis or over a tree. In an experimental vineyard at Tarnab some years ago, it was decided that as the hopper could not economically

be controlled, the production of grapes might be left to the cultivators of that tract which extends from Bad-ber to Bara Fort. There on the rich, deep alluvium, irrigated by the silt-charged, fertilizing red Bara water, grapes are grown to some perfection, and the leaf-hopper gives no trouble. In June and July when showers might injure the ripening branches, rain seldom falls. On this tract irrigation is almost too uncertain for the production of field crops, yet is sufficient for grapes. Here there is scope for establishing modern vineyards capable of supplying every market in India with grapes of first class quality. The cultivation of the pomegranate and quince is so simple that the Department has given less attention to them. Beyond finding in a trial that the most appreciated foreign quince varieties do not bear well or ripen perfectly at Tarnab, nothing to improve the production of this fruit has been undertaken. In the hot Peshawar Khalsa, under Kabul river irrigation, on efficiently-drained, fertile land, the orange is not thrifty and fruitful for more than ten or twelve years. On the other hand, in certain parts of Mardan and Charsadda which are irrigated by the Swat canals, the orange may have a long prolific life. For the Malta or Washington Navel the rough-lemon (*Citrus limonum* Osbeck) is the best stock : the Sangtara is most vigorous on the *mitha* (*C. limonum* var *mitha*). Unlike the orange the lemon grows and bears extraordinarily well almost everywhere in the Peshawar district. In tests during the last five years, the lemon stored in earthenware vessels has kept well up to five months. From the Tarnab nurseries 20,000 budded peach, plum, apricot and pear trees were distributed in each of the two seasons under review.

In BOMBAY, the Horticultural Section has rendered useful service in assisting the public to establish fruit orchards. Thus, over 3,000 *bor* trees were budded in different districts, notably in Satara and Kolaba. In Khandesh one owner has as many as 800 improved *bor* trees as the result of the assistance of the horticultural staff. In Khandesh, 400 Dholka pomegranate plants were supplied to agriculturists in Nashirabad village of Jalgaon taluka. The Taluka Association, Satara, distributed 10,000 Basrai plantain

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suckers with the aid of the Department. In North Gujarat, 2,122 grafts were supplied, while in Broach district the number of fruit-stock distributed was 557, with limes predominating. There is a keen demand for advice on horticultural matters in the canal zone of the Deccan, and useful assistance has been rendered in teaching the people how to prune grape vines correctly. The area under fruit trees is increasing in this tract, and here every effort should be made to foster the fruit industry. Further research has been carried out on the problems connected with the preparation of fruit juices from such fruits as lime and *jambul*, the latter of which is believed to have highly anti-diabetic properties. Work on the production of other fruit products including the candying of the *bor* fruit and the preparation of syrups has been in progress. The total quantity of fresh fruit and vegetables imported into Bombay by land and sea and the system of marketing and transport facilities available have been thoroughly studied and recommendations have been made to organise and improve the situation. In this province, as in the rest of India, the mango stands high in the list of popular and important fruits and continuous attention is now being given to the problems connected with it. Fruit is marketed by the growers and up-country dealers in a primitive manner, though in the Crawford market in Bombay grading of a high quality is the practice.

The Department has been demonstrating methods of grading and packing at Ratnagiri. Experiments in the latter have proved the superiority of wooden cases over bamboo baskets both as regards cost and the condition of fruit on arrival at the market. As regards grading, in 1931 about 2,000 baskets were graded by merchants with the aid of two departmental officers and in the early part of the season (*i.e.*, the latter part of April) there was an additional profit of Rs. 5-12-0 per hundred on graded over ungraded mangoes. With a view to the exploration and acquisition of new markets, trial consignments of Alphonso mangoes were sent in 1930 to Aden, Cairo, Marseilles and London and arrived in fairly good condition. Again in 1931 with the co-operation of the Empire Marketing Board and with the help of a small grant given by the

Imperial Council of Agricultural Research, small consignments of the best Bombay varieties of mangoes were despatched to London by the Government Horticulturist, Poona, by P. and O. Mail Steamers and kept during transit in the purser's cool room where the temperature ranged from 40° to 50°F. The fruit arrived in a fairly satisfactory condition and found a ready market. On the other hand, a large consignment was rather precipitately exported to London by a merchant without adequate arrangements for its transit or disposal, and the result has emphasised the need for an investigation into the problem of cold storage. It is hoped that, when a scheme now under consideration for the study of this problem fructifies, the subject will receive the intensive investigation it deserves.

Under the aegis of the Empire Marketing Board in a preliminary experiment at the Lister Institute, three varieties of mangoes were tested for the presence of vitamins with the result that the pulp of the Alphonso variety was found to be one of the most potent sources of vitamin C (anti-scorbutic), the Cowasji Patel variety was slightly less active but was as potent as the previously best known natural anti-scorbutic source, while the Shendrya variety contained in comparison little vitamin C. The pulp of all the three kinds contained vitamin A (anti-infective) in quantities similar to that possessed by butter but no very significant amount of vitamin D (anti-rachitic) was found in the pulp of any of them. As is mentioned in the report,* it would be unwise at the present stage to dogmatise too much from these results because the investigation is still in the preliminary stage but, in view of the importance of the mango, these experiments on fresh fruit might with advantage be repeated and further experiments made on preserved and canned fruit to ascertain the changes brought about in the vitamin-content by the treatment to which the fruit is submitted.

Work on horticulture in BURMA was confined mainly to the stations of Hmawbi, Mudon and Myaungmya. The Hmawbi

* Preliminary Report on the vitamin content of the mango. By Perry, E. O. V. & Zilva, S. S. Published by the Empire Marketing Board. (London: H. M. Stationery Office, March 1932.)

garden, 30 acres in extent, is by far the most important and has now reached the stage when the distribution of seedlings and grafts has become possible. During 1930-31, 952 plants of mango, plantain, lichi, citrus and guava were distributed. The Agricultural Assistant in charge of this Station conducted a survey of the fruit and vegetable supply of the Rangoon market. Some of the mango varieties flowered too late to suit Lower Burma conditions and are probably better suited to Upper Burma where they will be tried. The sapota continued to grow vigorously and most of the trees fruited. This fruit, which is not available in the bazars of Burma, is one of the species suitable for general introduction, especially as it comes into season in the hot weather when other fruits are scarce. The area under Kew pineapple is being gradually extended.

At Mudon the mangosteen, which is here in its native habitat, received much attention. Experiments have been made in shipping mangosteens to England in collaboration with the Empire Marketing Board and in bottling the fruit for use in the country or for export. Bottling experiments have only been commenced in 1931 and no results are as yet to hand. In connection with the experimental consignments of mangosteens to Europe, it is clear that the fruits must be shipped in cold storage as those shipped in ordinary storage arrived in very poor condition. Wastage was mainly due to rotting by *Diplodia*, a fungus which does not develop appreciably at temperatures below 50°F. All the fruits shipped in cold storage arrived in good condition and remained sound for some days after arrival. What is required to be done is to conduct experiments to find out the proper temperature at which this fruit should be shipped. The report of the Empire Marketing Board stated that " Samples of the mangosteens were shown to members of the trade who were distinctly interested and asked to be kept informed of the progress of the experiment. Numerous enquiries were also received from members of the public as a result of press paragraphs and of the mention of the consignment in the broadcast news bulletin. In view of the interest aroused, it seems possible that there are good prospects of a limited market for mangosteens if they can be shipped in consistently good condition ".

The appointment of a Fruit Expert in the PUNJAB has awakened interest in the starting of commercial orchards and in the supply of plants from controlled nurseries at Lyallpur and the other Government farms of Gurgaon, Gujranwala, Sargodha and Muzaffargarh. Several fruit-growing associations are functioning successfully and have been instrumental in arousing a desire among their members for better orcharding, better marketing and better control of diseases and insect pests. It is reasonable to expect that these should later become important organisations for the rearing and distribution of improved strains of fruit trees. A large number of varieties of vines, oranges, grape fruits, mangoes, pomegranates, dates, olives, etc., are under observation and from the study of these, valuable information is being collected. One of the most important achievements in the fruit work in this province was the spraying of 12,000 fruit trees in the Kulu valley to overcome the harm done by the San Jose scale insect.

Research work carried out in the Fruit Preservation Laboratory at Lyallpur centered round the curing of dates, the drying of apple rings and the manufacture of by-products from various kinds of surplus or damaged fruits. An example of the latter was the manufacture of vinegar from unmarketable apples and from dates damaged by rains at the time of ripening. The wide-spread appreciation of this branch of the work is proved by the fact that the demand for admission to the fruit-growing and fruit-preservation classes was far in excess of the numbers that could be admitted.

In the UNITED PROVINCES, though a certain amount of interest in the growing of fruit trees is included in the activities of all the Government gardens in the United Provinces, the main work is concentrated at the Saharanpur and the Chaubattia orchards near Almora. Varieties of trees have been introduced from other provinces and from outside India, including citrus and guavas from Australia, loquat from Japan, olives from California and stocks of apples, plums and cherries from East Malling.. The last have been budded and grafted with good varieties and planted out to test their suitability to Indian climate and soil. Included in these tests is a new variety of pear stock called *Pyrus calleryana.* Ex-

periments were carried out during the dormant season to destroy the woolly aphis which attacks fruit trees with such destructive effect and a certain measure of success attended the attempt to introduce the *Aphelinus mali*, a parasite, on this pest.

MADRAS. The fruits grown at Conoor were mainly plums, apples, quinces, persimmons, oranges, figs and guavas and 1,364 plants were distributed to growers. At Burliar and Kallar tropical fruit plants and spices were grown such as mangoes, mangosteens, guavas, sapotas, oranges, nutmegs, cloves and pepper. Efforts were made to increase the supply of grafted plants for which there is a growing demand and in 1931-32 1,268 plants were distributed.

In the CENTRAL PROVINCES, the demand for grafted mangoes and oranges is increasing year by year and hopes that concentration on this work will meet the growing demand seem justified. To test their capacity to fruit under the semi-tropical conditions of the Chindwara plateau, varieties of peaches, plums, pears, apricots, figs, lemons and oranges were planted some five years ago but though they flower well, they seldom set fruit and that not of esteemed quality.

At the BENGAL Government Farm and the Darjeeling Improvement Fund Fruit Nurseries, work is being done in propagating and distributing citrus, plums, pears, peaches, guavas, grenadillas, papayas, straw-berries, etc., and the number of cultivators applying for the fruit trees is gradually increasing every year. The cultivation of oranges and pineapples on the hills has expanded by leaps and bounds and every year thousands of such fruit trees and suckers are being planted.

In BIHAR AND ORISSA, in continuance of the procedure of the last few years, mango grafts of the choicest varieties were distributed and similar work has been done with lichies and guavas. For three years in succession, 1929 to 1931, though the mango has flowered profusely, the crop has been a comparative failure. At Sabour a record of the crop has been kept since 1920, and the three years 1923 to 1925 were also years of low crop. This problem of the intermittent bearing of mango trees is one of considerable

economic importance and an investigation of the various causes is being undertaken.

The appointment of an Agricultural Officer for BALUCHISTAN during the period under review will lead to further development of fruit culture in this administration. Work is progressing on grafting plums and peaches and 5,289 plants were distributed during the second year under report. Experiments were made on the control of insect pests, scale and aphids, and the results will be demonstrated in the near future.

Schemes for the intensive investigation of fruit problems are being prepared by the Departments of Agriculture in the Punjab, United Provinces, Bihar and Orissa, Assam, Madras, Bombay and Bengal for submission to the Imperial Council of Agricultural Research and, if adequate finances are forthcoming, there is a bright future for this aspect of horticulture.

13. Fodder Crops and Grasses.

One of the problems in the improvement of the live-stock of the country is the provision of more and better fodder in order to provide power in the working cattle, stamina in the young stock, and a better milk-supply. Rainfall is concentrated in a few months of the year and in the hot weather the temperature is in most places too high for growth. Improvement of the fodder crops by selection of suitable varieties and intensive cultivation so that they will provide a high enough yield to ensure a nourishing and ample ration for the whole year, is the problem before agriculturists. The solution is being sought in various directions as in the improvement of the grass of uncultivated areas, in the introduction and acclimatization of new fodder grasses, legumes and other plants, in intensive cultivation and in preserving the produce dry or as silage. The efforts and the measure of success that is being achieved in various parts of India will be described in the following paragraphs.

At PUSA, the cultivation of berseem (*Trifolium alexandrinum*) as a cold weather green fodder crop was continued in the low-lying

area of about 130 acres along the river side followed by maize and *meth* (*Phaseolus aconitifolius*) mixed in the hot weather by means of irrigation. During the season berseem required fifteen irrigations and maize and *meth* three. The cost per irrigation per acre by means of centrifugal pumps from the river was Rs. 2-2-6. A certain amount of green stuff was cut for fodder and silage and the rest of the crop was utilized for grazing. This area was brought under cultivation some eleven years ago and these crops have been grown continuously without any other manure than droppings of the cattle at the time of grazing. The exhaustive effects of this intensive cropping are now markedly visible as the yields of both berseem and maize have gradually decreased. In 1930-31 the yield of green berseem was 228 maunds per acre as compared with 468 maunds in 1923-24. Similarly the yield of green maize has gradually gone down from 300 maunds per acre to 159 maunds in the same period. It is proposed now to omit one maize crop every alternate year. A farm selection No. 1 white gave 169 maunds of green stuff against 117 maunds from the local maize in 1930-31 at Pusa, while at Lahore the same variety under irrigation gave 585 maunds of green stuff against 402 maunds of the local variety. This selection No. 1 gave 16 maunds of grain against 13 maunds for the local variety.

In BIHAR AND ORISSA, fodder crops received special attention on all farms. In addition to maize and *juar*, elephant grass (*Pennisetum purpureum*) and some varieties of sugarcane were found useful. Lucerne (*Medicago sativa*) when irrigation is available has proved to be of value. A strain of field pea, generally known as " Patna " pea, gave a very large yield of fodder especially suitable for dairy cattle. A mixture of Patna peas and oats cut green made an ideal feed for cows in milk though unfortunately its season is a short one. Many of these fodders are of limited application and what is required to improve fertility and to increase the cattle food supply, is the general adoption on a wholesale scale of suitable fodder catch crops after rice. *Khesari* (*Lathyrus sativa*) is grown to a certain extent but no greater improvement can be made than to get the principle of growing leguminous catch crops

generally introduced into village agricultural practice. This is the first step for a general improvement of fertility and for improvement in cattle conditions. It was proved at Pusa that berseem flourishes as well in Bihar as in Egypt. Few leguminous fodder crops give as high yields as berseem. Four to five cuttings or grazings may be obtained from October to April. Its only rival is lucerne which, however, is more of a garden crop. Berseem is a rotation crop of the highest value and produces fodder when fodder-supply is at its scarcest. One drawback is the fact that it does not produce seed in the Bihar plains. It is possible that it may do so on a practical scale at Ranchi and Netarhat. This is a very important point which is being investigated.

In BENGAL the Second Economic Botanist and the Livestock Expert have done much valuable work on fodders during these two years. Napier grass (*Pennisetum purpureum*) was the heaviest-yielding of all the fodder crops tried. It is perennial and propagated like sugarcane. Grown without irrigation, it gave 881 maunds per acre against 441 maunds from Guinea grass (*Panicum jumentorum*). Under irrigation at Dacca Sewage Farm, Napier grass gave 3,000 maunds per acre against 2,000 from Guinea grass. It seems possible that Napier grass will make an excellent permanent crop for a cultivator to grow near his homestead to furnish a perennial source of nutritious green stuff throughout the year. Early and late selections of *juar* (*Andropogon Sorghum*) from the Punjab and Bengal, respectively, were heavier yielders than Central Provinces types. Numerous American sorghum types were tried. As an early maturing, heavy-yielding fodder crop for green consumption or for silage, Kalimpong selections of maize were probably the best annual fodder crop. The public demand for good fodder is definitely on the increase, as indicated by the annual sale of nearly 4,000 maunds of green fodder at Rangpur and by the area put under fodder crops in the Nadia and Malda districts, where district live-stock officers were appointed two years ago. The next essential stage in development is the chemical examination of the various fodders with a view to comparing their respective nutritive values. The grant from the Imperial Council of Agricultural Research for entertaining a

Physiological Chemist for three years will enable this work to be commenced.

Of leguminous fodders, cowpea (*Vigna catiang*) was better than *mashyem kalai* (*Phaseolus Ricciardianus*) on the red soil at Dacca; but at Rangpur, on the grey silt, the reverse was the case. *Tonkola*, a type of *Mucuna utilis*, is a heavy yielder and a useful crop for bringing new land into condition.

Silage was made at all Government farms and an increased quantity by cultivators. Wherever the water-table does not come within five feet of the surface, pit silos were best. For places where pit silos were not possible an ordinary bamboo *gola*, as used for storing paddy grain, placed on a mound of earth, served to make excellent silage. Experimental manufacture of edible silage has been made from the following, at first sight unpromising materials: *aus* rice straw and water-hyacinth, *aus* rice straw and chopped banana stems, and similar combinations with sorghum. *Aus* paddy is of course reaped in the rains and often, on account of unfavourable weather, has to wait so long before drying that it rots or becomes mouldy and useless as fodder. Making *aus* rice straw into silage opens out the possibility of saving a great deal of valuable fodder.

In ASSAM, fodder crops are grown at the Upper Shillong Farm as a rotation with potatoes. The main crops are maize and local *raishan* (*Paspalum sanguinale*), the former being made into silage and the latter into hay. There is also need of a legume in the rotation and many have been tried, such as soy beans (*Glycine hispida*), lucerne, clover and cowpeas without great success. The local or Khasi *matai-kalai* has hitherto been found as good as any of these, but a further trial of lucerne and cowpeas is being made. *Paspalum dilatatum* (the famous "blue-grass" of Australia and Kentucky) does well on this farm and has held its own against local grasses without assistance for many years. An attempt is now being made to extend the area. At the Jorhat Farm experiments in making silage from the wild deep-water paddy and also from a mixture of dry paddy stubbles and plaintain stalk, chopped

and sliced, in equal parts by weight, have given excellent results and are sure to be of immense value to meet the fodder difficulty.

In the NORTH-WEST FRONTIER PROVINCE *shaftal* (*Trifolium resupinatum*) has been grown for more than half a century but berseem, which was introduced in 1911, has gradually been replacing it and now it covers a greater area than *shaftal*. It yields an earlier cutting and a considerably greater weight of fodder and is less inclined to induce Tympanitis in cattle. No disease or insect pest has yet afflicted this crop in the province. Chicory, however, was abundant as a weed in some places and the department has tried hard to induce the cultivators to pay more attention to harvesting a pure crop.

PUNJAB. *Kharif fodders.* In the PUNJAB, a trial to compare the yields of green fodder from crops commonly grown during the *kharif* was conducted. The test included Sudan grass (*Sorghum sudanense*), Sudan grass and cowpeas mixture, *juar*, *juar* and *guara* (*Cyamopsis psoraloides*) mixture, maize, maize and cowpeas mixture and *mavan* or indigenous cowpea. The result showed that in the first cutting maize alone and maize and cowpeas mixture in all cases, and also *jowar* and *guara* in some cases, gave the highest yields, but Sudan grass out-yielded all other fodders in the total of two cuts. Considered as a fodder plant, Sudan grass is one of the best on account of its leafiness and its ability to supply a large bulk of green fodder well distributed over the year. A further experiment to investigate the result of repeated cuttings on the seed-setting powers of Sudan grass showed that the uncut crop gave the highest yield of seed. The crop cut once gave a much reduced seed yield, whilst the crop cut twice failed to mature any seed, although the flowering appeared to be normal.

Elephant grass continues to increase in popularity by leaps and bounds. The Fodder Specialist's Section provided 100,000 planting sets to zemindars during the year against 30,000 in the previous year and even then many applicants had to be turned away disappointed. Its heavy yield and continuous supply of green fodder throughout the year are gaining for it a high place amongst the fodder crops in the province. Detailed studies were made of a

large number of single head selections of indigenous *juars* and mass selection work was carried out on the standing crop. The best yielders are under further trial. Cowpeas were tested for fodder yield at Lyallpur and various other places. Two-hundred-and-fifty maunds per acre of green fodder were obtained at Lyallpur, while at Kangra the yield was 300 maunds. Cowpeas is a very nutritive fodder and is likely to become very popular in the future. A large number of requisitions for seed was received. Various strains of hairy and non-hairy *anjan* grass (*Pennisetum cenchroides*) were under trial for the purpose of obtaining data as to the herbage produced during the growing period under a system of repeated cuttings. The yields fell gradually after each cutting but the percentage of leaf rose and on this account the palatability and nutritive value of the grass improved.

Rabi fodders. Fifty selections of *Senji* (*Melilotus parviflora*) made from the previous year's crop were under study, whilst the progeny of 130 single plant selections of *metha* was under experiment. Further trials carried out with five types of rapes confirmed the results obtained in the previous year that the Japan white-leaved rape produces the highest yield of fodder. Thirteen varieties of oats from New Zealand, five from Algeria and sixteen from local sources were under study. Two of the New Zealand types produced tall and heavy-yielding crops. Another New Zealand type, almost equally good, had the additional advantage of remaining green much longer than the others. Algerian oats were tried for the first time and appear to be promising, both as regards quality and quantity of fodder produced. They appear to mature late—about the middle of May—and may prove to be a possible source of green fodder late in the season. Further tests remain to be carried out on all these varieties. Following on the Fodder Specialist's examination of the grasses in the lower Murree Hills, work was commenced in collaboration with the Forest Department on the improvement of hill forest grazing areas. Both berseem and *shaftal* have been tried under well irrigation, sown immediately after rice. When sown in the standing rice crop they did very poorly, but when sown by breaking the land after the removal of the rice crop they did

well, giving 5 cuts and yielding at the rate of about 490 maunds of green fodder per acre in the case of berseem and 750 maunds per acre in the case of *shaftal*. Egyptian farmers get a very important part of their winter fodder by growing berseem after rice, and this experiment was started in order to see whether Punjab rice farmers could also benefit in a similar way.

In the UNITED PROVINCES, interesting experiments have been made with the various kinds of fodders grown on the cattle farms. The results with sunflower (*Helianthus annuus*), both in the green state as well as silage, have been particularly satisfactory, and it can be recommended to all cattle-owners who want a supply of green fodder during the cold weather. Satisfactory results were obtained also from Guinea grass (*Panicum maximum*), Elephant grass (*Pennisetum purpureum*), and the high yielding indigenous variety called *rata* grass (*Anthistiria ciliata*). The latter makes excellent silage and is relished by the cattle. Various other fodders, such as Sudan grass, Wimmera rye grass, cocksfoot, subterranean clover, Italian rye grass, Timothy grass and also broom corn were tried. The results, however, have been poor and do not justify further trials being made.

In the CENTRAL PROVINCES, the question of fodders and grazing has continued to receive attention and the suitability of selected strains of *shcora* (*Alysicarpus rugosus*) and soy bean (*Glycine hispida*) as forage crops to supplement ordinary grasses has been confirmed. Fairly complete information is also now available regarding the botanical nature and agricultural possibilities of practically all the grasses occurring in the province. It is worthy of note that only the indigenous grasses deserve consideration and by re-seeding, rotational grazing and fencing, grass land can be effectively improved. In conjunction with the botanical work, determinations of the nutritive value of the commonly occurring grasses have been continued and in view of the low feeding value which such analysis often indicate, the effect of various manures upon the quality of pasture grasses has been studied. This work will be given more permanency by laying out replicated plots on the Telinkheri Farm.

The research on grassland was continued by the Economic Botanist, BOMBAY. At Bhamburda, the system of rotational grazing using four ten-acre blocks and 20 cattle was continued. From each ten-acre block grazed this year two acres were fenced off and the grass cut in order to estimate the amount of feed produced and thus judge of the effect of the treatment. The animals were in healthy condition throughout the year and increased in weight till the end of December. There was some falling off of weight thereafter, but this was retarded when silage made from the grass of the area was fed to them during the hot weather. This silage was made in a silo pit excavated on the site, the amount of grass put in being 24,000 lbs. No other food except grass grazed or stall-fed as hay or silage has been given to the animals. The vegetation of the Bhamburda area continues to improve. Construction of contour bunds has helped a good deal in checking soil-erosion and increasing the plant population. This experiment will terminate on December 31, 1931. It is gratifying to report that the Forest Department are prepared to try out these methods on a large scale in a grazing area under their control near Poona, and at their initiative a scheme is now under consideration for applying the principles of rotational grazing to an area of land in their control. If this materializes and proves successful, then the co-operation of the Forest and Agricultural Departments will have gone a long way towards solving the problems of prevention of erosion, improvement of forest grazing lands and better nutrition of cattle, all of which are inextricably bound up with one another. At the Cattle Farm, Chharodi, 240 tons of hay were made in 1929-30. Hay-making by machinery has progressed considerably ; the cost has been reduced to two rupees per 1,000 lbs. Next year, however, half the standing crop was sold as this farm had a big store of hay. In tests carried on for several seasons, it became evident that the local *jowar* was superior to all other varieties, that maize and *bajri* did not compare well with it, and that pulses with the exception of *chavli* (*Vigna catiang*) did not yield well and were too expensive to grow and watch against wild animals. Elephant grass and berseem were experimented with.

In SIND, experiments are being made with berseem, oats and soy beans. It is hoped that, as berseem is *kalar*-resistant, it may be useful in solving the problem of reclamation of saline land.

In the north-eastern part of MADRAS, sunn hemp is the most important fodder crop. It invariably follows the rice crop and is usually cut when it is in full flower and made into hay. It may yield 240 maunds of green stuff per acre but when rice is lodged, however, as it was in 1930-31 after a cyclone during harvest, the sunn hemp crop is poor. A quick-growing wild plant, *Phaseolus trilobus*, is gaining ground as a fodder crop and is increasing rapidly in the deltas. In Chittoor and Coimbatore districts sorghums were the popular fodder plants, the variety called *kaki-jonna* giving 208 maunds of green fodder.

At Koilpatti, manurial trials with ammonium sulphate and groundnut-cake in conjunction with superphosphate on fodder sorghums and *Pennisetum typhoideum* were made. In the first year striking increases in yield were obtained but in the second year differences were not so marked. Ammonium sulphate proved superior to groundnut-cake. Selection work on fodder sorghums was started in 1930-31 at this station.

Various grasses like Guinea grass, Elephant grass and *kolu-kattai* grass were being taken up in some places. On the hill slopes large quantities of green grass are available after the rains. A certain amount is cut for thatching purposes when it is dry and the rest dries up and becomes waste. On the advice of the department, some of the ryots prepared silage from this hill grass when it was green, and fed their cattle during the hot weather when succulent fodder was scarce. The silage prepared was good and the cattle relished it well. The Systematic Botanist was engaged on the survey of grazing areas in the departmental farms and in several districts. One hundred-and-seventy species of grasses were collected and were being analysed by the Agricultural Chemist with a view to estimate their feeding value.

The fodders of BURMA are *jowar* in Upper Burma and rice straw in Lower Burma. Burmese *jowar* is of two kinds, the red-seeded *jowar* in which the seed is of inferior eating quality and which is

used mainly for cattle food, and the white-seeded variety of which the seed is an important article of food in parts of the dry zone districts. The seed of this crop is often badly attacked by smut but during the years under report the crop was fairly free from this disease. In addition, at Tatkon, Saccoline, an Australian variety of *jowar* is also grown. Merkers grass which is also a useful introduction gives a continuous supply of fodder throughout the year except in the three dry months February to April. On the Mandalay Agricultural Station, berseem and lucerne were grown, the former being broadcasted in the standing crop of paddy and allowed to grow after harvest and the latter being sown on raised beds as an irrigated dry crop. These two fodders serve a useful purpose where dairy cattle are kept but they cannot be introduced into the general economy of the dry zone, where *jowar* continues and appears likely to continue to hold the first place as a food for working bullocks.

14. Millets.

The principal millets cultivated in India are *jowar* (*Andropogon Sorghum*), *bajra* (*Pennisetum typhoideum*) and *ragi* (*Eleusine coracana*) and they occupy together an area of about 56 million acres. Of these *jowar* is by far the most important, occupying as it does, 33 million acres, an area larger than that of wheat. *Bajra* comes next with 13·5 million acres and *ragi* has nearly 6·5 million acres. Several other millets are of importance locally but are not important enough to be reported separately.

Jowar. The area under *jowar* was 30·9 million acres in 1928-29. It increased by 7 per cent. to 33·2 million acres next year and was 33·1 million acres in 1931-32. The chief *jowar*-growing areas in order of importance lie in Hyderabad, Bombay, Madras, Central Provinces, United Provinces and the Punjab. It is also cultivated as an important fodder crop in most agricultural areas in India. In two provinces, Madras and the Punjab, Millet Specialists are in charge of the work of development.

In HYDERABAD STATE which has twenty-nine per cent. of the total area in India, selection work was begun at the Experimental

Farm, Parbhani, which is mainly devoted to wheat and *jowar*. Already one dwarf and one tall variety have done well.

BOMBAY has 28 per cent. of the total area under *jowar*. The most promising type for the Surat area was Budh Perio No. 53. At the Surat Experiment Station 70 acres laid down to this variety gave an average yield of 883 lbs. per acre. In properly replicated tests this variety has given for the last five years on an average 19 per cent. more grain than the local variety. At Mohol work on selection of high-yielding strains of Maldani and Dagadi progressed. These two varieties continued to give good results and were spreading in West Khandesh as a *rabi* crop. The advantages to be obtained by the grading of *jowar* are becoming widely appreciated. This is a very simple operation which can be done by hand-sieves. In Barsi Taluka of Sholapur district 13 villages have adopted the method wholesale, and as a result of propaganda in Sholapur district 544,526 lbs. of *jowar* seed were graded, of which the department directly graded about one-half. This is exclusive of the grading done by private persons and co-operative societies. The average increase in yield of the *jowar* crop, from graded seed, distributed over a large area, was 32 per cent. in the case of the grain and 15 per cent. in the case of the straw. At the Dry Farm at Manjri, where Kalbondi, a variety of *jowar*, is the most important crop, experiments were carried on regarding bunding, mulching, manuring and cultivating, and valuable results were obtained which are being actively demonstrated to the cultivators of the dry zone.

Approximately five-and-a-half lakhs of acres are cultivated annually in SIND under *kharif jowar*, largely in the northern districts. Under perennial irrigation from the Lloyd Barrage and Canal Systems, a considerable increase in this area must be anticipated in view of the increased demand for grain for human consumption and of fodder for work animals. There are about fifty-five different varieties of *jowar* in Sind and all of these have been grown at Larkana and at the Agricultural Research Station, Sakrand, where a detailed scientific classification of the crop has been made. As a result of selection from this material, several varieties have been obtained which are outstanding for high yield and hardiness and

improved strains of each of them have been evolved. These selected strains—Saoro Kartuho No. 1, Bagdar No. 1, Red Janapur No. 3—yield from 20 to 40 per cent. higher outturn than the ordinary crops now in cultivation in Sind and seed is being multiplied by departmental agency as rapidly as possible for further extension in the districts. Three American varieties of grain *jowars* were tested but did not approach the local improved varieties in point of yield. Hybridization work is also in progress and attempts are being made to impress the character of heavy weight of grain possessed by a local variety, named Torh, on the selected high-yielding strains evolved by the department.

In MADRAS, where 15 per cent. of the area under *jowar* is situated, the improved strains already introduced in the Deccan are T1 and T6, and in the two years under report 4,360 and 11,280 lbs. of pure seed were distributed. A new strain N. 23/10 is likely to replace the older strains. A yellow strain A. S. 809 and a white strain A. S. 1543 seemed best suited to Coimbatore, and in 1930-31 when the season was most unfavourable to *jowar* they still gave a better yield.

Bajra. The total area reported under *bajra* is about 16 million acres but though reports are not received from all areas, the figure is not far short of the actual total. The chief *bajra*-growing provinces are Bombay, the Punjab, Madras and Bihar and Orissa. In BOMBAY, selection work has been going on for many years and several selections are already established. Akola *bajra* was popular and was being appreciated in other districts as well. To meet the demand for pure seed about twenty-two thousand lbs. were distributed in the period under review. Three new races tested against the Akola variety showed improvement. As was the case with *jowar*, seed-grading was found to be profitable. Both in the PUNJAB and the CENTRAL PROVINCES selection was in progress and some strains look as if they are going to replace existing strains; indeed at Akola, two strains are already replacing the local variety.

Ragi. *Ragi* is grown on an area of about 6·6 million acres of which Mysore and Madras have one-third each and Bombay and Bihar and Orissa have most of the remainder. As *ragi* is the most

important single crop in MYSORE, much attention continued to be devoted to it both at Hebbal and Hunsur. Three strains H. 2, H. 22 and H. 40 have now been widely distributed and nine of the more recent selections showed themselves superior to the local variety even under the trying conditions that obtained in the season 1929-30. A number of newer selections have become available for multiplication and some have been distributed for trial. In MADRAS this crop has been studied intensively at Coimbatore in the south and Anakapalle in the north. The strain E. C. 47 has proved to give a higher yield than the old improved strain T. 8 evolved at Hagari but as it matures later, it requires more water. There is some hope, however, that another new strain E. C. 593 which matures a week earlier will be more suitable. Strain No. 525 looks as if it would replace local *ragis* in the northern area. To test whether *ragi* can be grown throughout the year, a seasonal experiment has been started with one long and one short period variety. In the Konkan in BOMBAY four strains A. 16, B. 11, E. 31 and E. 82 that proved superior to the local varieties were distributed to registered seed-growers.

At Kalimpong in BENGAL selection work was also in progress and one type No. 46 promises to be a good yielder.

15. Other cereals.

Maize is grown in about six million acres of which about two-thirds are in the United Provinces, the Punjab and Bihar and Orissa. In all these provinces, selection is now being carried out but as this crop takes a long time to improve, none of the selections are yet ready for distribution. At PUSA, 12 selfed lines in the white-seeded race and 15 in the yellow-seeded have been under study for the last 4 and 5 years, respectively, but none has become pure yet. The work of getting them pure by in-breeding will take 2 or 3 more years. In BIHAR and ORISSA a selection that showed promise of being better did not come up to expectation. In the UNITED PROVINCES, Jaunpore maize continued to be popular and Peshawar white maize continued to be the most suitable variety for rotation with wheat in the NORTH-WEST FRONTIER PROVINCE,

Barley. Barley is grown on about 7 million acres, two-thirds of which are in the United Provinces. The exports of barley have declined almost to vanishing point during the last two years from 138,000 tons in 1928-29, which was a year of abnormally high export, to 6,000 tons in 1929-30 and 100 tons in 1930-31. The price declined from Rs. 34 per candy of 656 lbs. in 1928 to Rs. 20 in 1931. A classification of nineteen types of 6-rowed barley and five types of the 2-rowed variety together with a study of the root-system of most of them was published in the *Indian Journal of Agricultural Science*, **I**, Pt. I. Yield trials with the four best types, T. 21, 20, 12 and 7, were made in both years under review and the yielding capacity was in the order named. Type 21 has been tried in several places. At Makrera, Rajputana, the yield was 2,152 lbs. per acre, at Dholi 3,845 lbs. and in Pusa 2,570 lbs. and at Shahjahanpur 2,683 lbs. per acre. Rather an interesting point arose out of this trial in that the results suggested that T. 21 utilized borders to a greater extent than the other three types, probably by virtue of its greater tillering and standing capacity. In an estimation of the malting value, T. 20 had a high diastatic activity while T. 21 was rather low. During the year 1930-31, 4,358 lbs. of Type 21 were distributed for trial.

UNITED PROVINCES. Two of the new strains isolated in 1927 were found to be promising and seed was distributed to compact areas in order to elicit the opinion of the grower. In a varietal trial at the Shahjahanpur Research Station, these two varieties, B. 251 and 255, gave an yield of 38 to 39 maunds per acre, while the other Pusa varieties tested with them gave 32 to 34 maunds. B. 251 has proved to be the best both in yield and quality. Samples were sent for examination by experts of the Institute of Brewing, London, and favourable reports have been received.

BIHAR AND ORISSA. For the last four years in Bihar and Orissa Pusa B. 4 proved to be very much superior to local varieties and 500 maunds of seed were released to growers.

Oats. The Pusa selected types B. S-1 and 2 are still in demand among Bihar planters and others. Some better strains evolved by hybridization of these oats with the Scotch Potato and the Abun-

dance varieties, respectively, show definite improvement in the plumpness and yield of grain and the profuse quantity and strength of straw.

Though in small-scale trials the types B. S-1 and 2 gave greater yield yet in a large-scale yield trial, when forty balanced strips each half an acre in area were sown alternately with the two varieties B. S-1 and P. F-1, a farm selection, the difference in yield was not statistically significant. The large-scale trials will be repeated. In a field trial B. S-1 was tried against a Lyallpur strain and found to be a little less susceptible to smut.

16. Potatoes.

The work on potatoes in all provinces in which they are grown was confined to testing varieties, manuring, storing and distributing acclimatized tubers. Only in the Punjab and Bengal has an attempt been made to select new strains from seed. In the former province crossing has been tried but without success so far, on account of the fact of the almost complete absence of viable pollen.

Varieties. In the PUNJAB, as has been the case for several years, the various Scotch varieties gave much higher yields than local types in the Simla hills. On the average of a large number of experiments, these varieties yielded about forty maunds more tubers per acre than the local varieties and were of better quality and size. Based on the price at the time of harvest in 1931 of Rs. 2-8-0 per maund, growers of the improved varieties had a net gain of Rs. 100 per acre. Certain English varieties and five of the nine new Scotch varieties all of which were introduced recently also showed considerable promise. Similarly on various farms in the plains certain of the imported varieties taken from the hills have proved distinctly superior to the local varieties. In the UNITED PROVINCES, which have an area of 153,500 acres under potatoes, at the Potato Research Farm at Farrukhabad, it has been found that " seed " from the hills gave far better results than that which is saved from the crop in the plains and an attempt is being made to organise the supply of hill-grown " seed," so that sufficient quantities may become available to agriculturists in the plains at the proper time.

Already for the plains of BIHAR and BENGAL " seed " is brought from the hills around Darjeeling and Shillong. The potato is an important crop in the Southern Shan States of BURMA. A few of the introduced varieties are now widely distributed, the most important being Up-to-Date, Ally and Great Scott. A summary of the information regarding this crop was made in 1931 and published as Agricultural Survey No. 10 of the Burma Department of Agriculture.

Storage. In all parts of India where potatoes are grown difficulty is found in storing them from the time they are lifted from the ground till the time of replanting. Losses due to rotting in ordinary methods of storage as practised by the cultivators and merchants always occur and they often run between 30 and 50 per cent. of the crop put in store or even higher, and this loss is a limiting factor in the extension of the crop. Rotting is mainly due to the attacks of bacteria, *fusaria* and insects, especially the potato moth *Pthorimaea operculella*, and experiments to try to find a simple method of reducing the losses were carried out in every province and State in India where potatoes were grown. In the UNITED PROVINCES a cold storage method has proved to be effective but it is available only to big merchants and can have no general utility. However, a simple and effective method has been devised to reduce the loss caused by the potato moth which here does most damage, and consists in covering the potatoes with sand immediately after harvesting and at intervals passing the sand through a wire gauze sieve in order to remove the pupae. The moths that come out of infected tubers were found to pupate in the sand. In an experiment in 1931 at the Research Farm, out of 190 maunds of potatoes stored for seed only 9·5 per cent. rotted, including the quantity discarded before storage, because of primary infection and also wet and dry rots. The solution of the problem is also being sought in the form of an earlier maturing variety which is being acclimatized by growing it alternately in the hills and the plains. In the PUNJAB, the continued study of the behaviour of potatoes stored in an under-ground chamber shows that while the temperature of the chamber is generally about 80° F. and is beneficial for storage,

the humidity remains as high as 96 per cent. As a result of this excessive dampness the advantage gained from the low temperature is lost to a great extent. Even with this disadvantage the percentage of loss due to decay in this chamber is considerably less than under ordinary storage conditions. In the latter case the loss during the year was as high as 90 per cent., whilst in the former it was about 42 per cent. Another advantage of storage in a chamber of this kind lies in the greater germinating power of the seed. With a suitably designed chamber, provided with ventilation and giving a temperature of about 80° F., combined with a low humidity, the loss due to rot should be minimised considerably and the germination capacity should be much higher than in the case of potatoes kept under ordinary methods of storage in potato-growing districts. At Nagpur in the CENTRAL PROVINCES, storage experiments showed that during the hot weather potatoes could be saved at a very small cost and without any appreciable loss but during the monsoon months the loss was considerable. At PUSA, DACCA and SHILLONG experiments on treating potatoes before storage with various chemicals did not meet with much success.

In the PUNJAB, another line of investigation for overcoming losses during storage so far as " seed " is concerned is to take hill potatoes immediately they are harvested to the plains and plant them there on arrival, but such seed potatoes harvested in the Simla Hills in September do not germinate satisfactorily if planted in the plains in October. With a view to accelerate the changes that take place during storage, freshly-lifted potatoes have been subjected to a number of chemical and physical treatments. By a combination of chemical and temperature treatments all the potatoes were made to sprout within three weeks after treatment. Field trials with the treated and with untreated potatoes were being carried out at Mashobra but the results are not yet available.

Manuring. In MADRAS, a mixture of fish guano, super-phosphate and muriate of potash has given higher yields and the growers in the Nilgiris are using artificials in increasing quantities, while in ASSAM artificial nitrogenous manures gave great promise in the Khasia hills.

Mosaic. After rogueing mosaic plants for three successive years, the crop which originally had an infection of 70 per cent., both on the farm at Farrukhabad and elsewhere, was free from the disease. In the PUNJAB too this was being done with some success.

17. Beans and Pulses.

This group of crops is important from every point of view. As rotation crops they are intimately concerned with the maintenance of soil fertility ; for a population which is largely vegetarian they form an article of diet of primary importance ; they provide part of the concentrated food for working cattle and certain pulses are an important item of export. If falling prices for cereals and fibre crops, coupled with the use of higher-yielding varieties of these crops (thus maintaining the same standard of production on a smaller area), leads to an increase in the area under pulses, the eventual gain to the agriculture of the country might be considerable.

Gram. One of the most important of the pulses is gram *Cicer arietinum.* The area under this crop in 1928-29 was 14,951,000 acres, in 1929-30, 13,245,000 acres and in 1930-31, 12,399,000* acres, but taking Hyderabad figures which are not yet available for 1930-31 to be the same as those in 1929-30, *i.e.*, 1,106,000 acres, the total for 1930-31 would be 13,505,000 acres. With 5,424,000 acres the United Provinces has the largest acreage and the United Provinces, Punjab, Central Provinces and Bihar and Orissa have between them 76 per cent. of the total area.

So far the recorded area under improved varieties was about 1·5 per cent. of the total area and of this 75 per cent. is in Burma. As most provinces include the area under improved kinds of gram under other crops, the true figure for this crop cannot be found but it must be comparatively large.

At PUSA the description and classification of the 59 new and 25 old types was revised and published in 1930. The study of some crosses made in past years indicated that the general constitution of the white flower was not the same in all white-flowered types

* Incomplete.

and that the pink colour in the flower resulted from the interaction of two factors, one of which produced blue and the other modified this blue to pink. The gigantic mutant Type 79 compared with its original Type 24 showed that there was an increase in the size of the cells, in the number of layers of various tissues and in the number of chromosomes.

The UNITED PROVINCES is the premier gram-producing province in India. The two chief varieties grown are two Pusa types, and the department supplied 10,000 lbs. of pure seed in 1929-30 and 11,500 lbs. next year. Selection of pure varieties and hybridization with a view to evolve a hardy prolific variety was also in progress.

In the PUNJAB the three best types of gram Nos. 7, 15 and 17 out-yielded the local sorts in the three areas for which they are most suitable. 365 maunds of pure seed were distributed in 1930 for sowing the next year's crop. In 1930-31 a new type No. 19 out-yielded all the other varieties and showed promise. Gram blight is under study.

In the CENTRAL PROVINCES samples of grams were collected from all over the province and selection was begun. Wilt caused severe loss here and a recent selection No. 515 has proved to be wilt-resistant and will be utilized to impart resistance to other strains of higher cropping power. The three wilt-resistant samples of gram from Poona and Cawnpore were poor yielders in the Central Provinces, but they will be used also for the production of profitable wilt-resistant types.

In BIHAR AND ORISSA the results of the yield trials of Sabour 4 and Pusa No. 17 for the past 4 years pointed to the decided superiority of the Sabour selection for South Bihar conditions. Some of the hybrid grams superseded the existing gram types both in yield and quality. Generally, size of gram went along with lower yield but in the hybrids some seemed to be capable of giving a good yield combined with large, bold, coloured seed. They need to be further tested before they can be supplied to the departmental farms. The study of the genetics of this crop was in progress and useful information regarding the inheritance of quantitative and qualitative characters has been recorded.

In BURMA about 70 per cent. of the area grown was under improved varieties. In 1929-30, 1,420 maunds of pure seed were distributed and in 1930-31, 1,940 maunds. The Karachi gram, introduced by the Department of Agriculture about 10 years ago, still maintains its superiority and has replaced the Burma variety. A disquieting report that in some localities it is beginning to show signs of wilt is being investigated, and selection of the Karachi gram was undertaken.

In BENGAL Sabour 4 and Pusa 18 were the two leading varieties. Though the former is about two weeks earlier the cultivators prefer it. The classification of Bengal gram was completed.

Pigeon Pea. At PUSA varieties of pigeon pea were classified and described. Two of the types with a spreading habit are highly wilt-resistant and a hybrid as well. Work was in progress to combine erect habit with wilt-resistance. In BURMA a new strain C. 10, free from the condition known as "green ear" and with a shorter growing period, has found favour with the cultivators. In BIHAR AND ORISSA, among the erect varieties Sabour 2-E proved to be the best yielder and was far superior to all the erect Pusa *rahars*. As regards the spreading varieties, one Pusa type and Sabour 7-S. were equally good. The observations of the last three years have established that a few types are resistant to the "sterility disease". Particular attention was paid to erect types because, when grown in rows, cultivation may be done by means of bullock hoes. In the CENTRAL PROVINCES a description of types of *rahars* in the province has been published. Only early-ripening types do well here and the best having regard to yield, quality and flavour was Type 8 No. 3 and there was a considerable demand for its seed. Here too attention was directed towards obtaining wilt-resistant strains.

Peas. At Pusa and at Sabour in Bihar and Orissa, the isolation of unit types of both *Pisum sativum* and *P. arvense* was in progress. At Pusa and in Bengal the same was being done for *urid* and *mung*, *Phaseolus radiatus* and *P. mungo*, also for lentils (*Ervum lens*, Linn).

In Burma too work on *urid* and *mung* was in progress and selections were tried out in some of the farms.

Beans. The main work on pulses in Burma centres on the introduction of the new Burma butter bean which promises to be a valuable addition to the agricultural economy of the dry zone. This is a variety of *Phaseolus lunatus* which was obtained in a small sample from Egypt some six years ago. It has since been selected to give a yield corresponding to that of the indigenous Rangoon white bean from which it is scarcely distinguishable in the field. The seeds, however, of the butter bean are larger and flatter and of much better cooking quality than the former. Work with this bean consisted in multiplying it for the purpose of providing experimental shipments and also to produce pure lines of the type which the trade in Europe seems most to demand. Some of the seeds have a yellow colouration which reduces the value of the bean and it has been found that this can be eliminated by pure line cultures which do not contain this colour. Selection work continued at the Mahlaing Agricultural Station where ten single cultures selected last year were compared against each other. One was found to be the best all-round strain. At the Tatkon Agricultural Station it was found that the application of the fertilizer nicifos not only had no effect on this bean but actually depressed the yield. Spacing experiments were also done which proved that $2\frac{1}{2}$ by 3 feet is the most satisfactory spacing. A large number of single plant selections were also made for further examination and test. In 1929-30, through the Burma Chamber of Commerce, twenty-two tons were sent as a trial consignment to London, where it realised £22-10-0 a ton when Rangoon white bean was selling at £14-10-0. Next year a shipment of twenty tons was made and the price obtained was £20 per ton against £10-10-0 for Rangoon white bean. The department considers that it should adopt a conservative policy and maintain control over the cultivation of the bean till such time as a market has been established.

CHAPTER III

RESEARCH AND INVESTIGATION.

In the summary of economic work on crops, given in the previous chapter, reference has been made to a good deal of research work in progress particularly in economic botany. In this chapter an attempt is made to refer briefly to the research work on the more important problems in the different branches of agricultural science and to some of the results obtained. More detailed information will be found in the *Scientific Reports of the Imperial Institute of Agricultural Research, Pusa,* and in the reports of the research officers of the various provinces and States.

1. Soils.

Surveys. Soil-surveys of the Pegu district and of the Mandalay canal area in Burma, of the areas under the Haveli project and of the three extensions of the Lower Chenab canal in the Punjab, were made. A geological and agricultural survey of an area of 70,000 acres under the Irwin canal in Mysore was practically completed, showing particularly the areas suitable for sugarcane cultivation. The survey of Jorhat in Assam was in progress.

Base-exchange. In MADRAS a systematic study of the important types of South Indian soils for the nature and amount of replaceable bases was begun. As a preliminary step, a method suited to calcareous soils has been evolved, which consists in using for extraction a mixture of sodium carbonate and sodium chloride at a pH of 7·8. The application of sodium nitrate to swamp paddy soils up to a maximum of 3 cwts. per acre per annum continuously for five years did not induce alkalinity, but the irrigation of garden soils with well water containing large amounts of sodium salts interfered with the soil complex producing harmful results. The extent to which sodium can be allowed to enter into the soil complex and the safe limits of the range of the lime-soda ratio were under investigation. Examination of a number of paddy soils from Coimbatore, Aduturai and Godavari showed that they are un-

saturated. This appeared to be the result of a swamp system of cultivation, involving the leaching of the soils continuously with water saturated with carbonic acid gas or from the nature of the manures used. It was found that the continued use of ammonium sulphate, superphosphate and potassium sulphate, singly or in combination, changed the cationic composition of the soil clay. Superphosphate produced the least change, potassium sulphate produced the most. In mixtures the action of each fertilizer was independent. With ammonium sulphate, lime replacement was even less than in the manured plots. The following explanation was offered. The soils have sufficient supplies of calcium carbonate and, therefore, the nitric acid resulting from the oxidation of ammonium sulphate would dissolve lime and maintain its concentration in the soil solution and set up a reaction in the reverse direction ; this helped to maintain the lime status of the soil. The status of the soil under continued use of ammonium sulphate is therefore apparent and not real and it should not be interpreted that no lime depletion occurred. The exchange reaction being instantaneous, lime depletion does occur immediately the soil comes into contact with a solution of ammonium sulphate, but later on the nitric acid resulting from the oxidation of the ammonia brings more lime into the soil solution, and sets up a reverse reaction thus maintaining the lime status of the clay complex.

The determination of replaceable bases in BURMA soils was continued using Hissink's method, and a large number of soils in the Pegu and Mandalay canal area were completed. In addition, an electro-dialysis method for extracting replaceable bases from soils has been investigated and promises to be an improvement on the methods depending on treating soils with either neutral salts or dilute acids, inasmuch as the resulting solution is much easier to analyse since it contains the bases as hydroxides uncontaminated with large amounts of sodium or ammonium chlorides which are difficult to remove, particularly for estimation of potassium and sodium.

In BIHAR AND ORISSA the problem of acidity of the soils of Chota Nagpur and parts of the deltaic region of Orissa was investi-

gated, as well as the changes in the soil reaction and the amount and character of exchangeable bases due to continuous manuring with certain fertilizers. Permanent plots have been laid down in the Kanke, Ballia and the Cuttack Farms and experiments are in the second year. The coastal area is at times flooded by sea water raised by high winds and the irrigation water itself is sometimes saline. There the condition of the land is damaged in texture and the *gur* made from sugarcane has a salty taste. The effect of lime and gypsum in excluding sodium salts by base-exchange in the soil is being investigated.

Mechanical analysis of soils. At the DACCA UNIVERSITY three existing methods and one new method of mechanical analysis were tried on a number of samples of lateritic soils, two from Dacca and four from the districts of Hazaribagh and Santhal Parganas in Bihar, in order to find which method gave the maximum dispersion. The methods tried were : (1) the International method but without the peroxide treatment since lateritic soils contain little organic matter, (2) the sodium chloride method as developed by Dr. Puri, (3) the sodium carbonate method as developed by Dr. Joseph but using the pipette technique in place of sedimentation and (4) the sodium hydroxide method in which an attempt was made to disperse the soil with a small dose of sodium hydroxide without the previous sodium chloride treatment as in (2) or the acid treatment as in (1).

In addition, four more Dacca soils were analysed by (1) and also by (2) and 14 other Bihar soils by (2). Complete analyses were made in all cases. Both the International and sodium chloride methods dispersed all the Dacca soils practically to the same extent, but in the case of two out of four Bihar soils the amount of clay obtained by the latter method was distinctly greater. There was also a loss by solution of soil materials to the extent of about one per cent. as a result of the acid treatment in the International method. On adopting a much longer period of shaking in either method, no gain in the amount of clay or clay plus silt was obtained. This shows that in the case of lateritic soils the maximum dispersion was obtained by the prescribed treatment for each

method. In all cases the sodium carbonate and sodium hydroxide methods gave much smaller amounts of clay than did the other two methods. The lower dispersion with sodium hydroxide is believed to be due to the fact that the amount of alkali added was insufficient to convert the whole of the clay into sodium clay. But this was not so in the case of sodium carbonate method.

In BENGAL the results of a comparative examination of methods of mechanical analysis of typical Bengal soils indicate, contrary to expectation, that the laterite alluvial soils of the Bharind and Bhowal jungle tracts present no difficulty in dispersion but that soils containing considerable percentages of lime, mica and organic matter may offer greater difficulty.

In MANDALAY some 210 Burma soils from three distinct tracts have been examined for percentage of clay, air-dry moisture, loss in ignition and moisture at sticky point and the correlations worked out. The conclusions are at variance with those obtained by Keen and Coutts in similar studies.

Soil-acidity and lime-requirement. The deep alluvial soils of SIND vary very much in their character from place to place. Further tests of the soils at different spots on the farm showed that the pH value of the soil, free from any soluble salts, was about 7·5 as against 8·5 to 9·2 found on spots affected by *kalar* or salts in varying degree. Failure of crops on such soils as show a pH value of 9·2 and above may be ascribed to the greater alkaline reaction of the soil but a similar failure of crops on land having a pH value of 7·2 and containing very little or inappreciable quantity of soluble salts indicated that the cause of barrenness may lie in bad physical texture of the soil and want of plant food or bad cultural treatment. In the acid soils of DACCA and JORHAT limed plots in all years have given a higher yield. Rain and the presence of water in the field have a decided action in altering the pH value and bringing it more or less towards neutrality, specially in the water over the plots. The mud shaken up with supernatant water has often given a higher pH than that of supernatant water. The analysis of supernatant water so far has revealed little ; but it has given a large percentage of soluble manganese as compared

to that of Rajshahi where the amount was a mere trace. To the alkaline soil of Rajshahi sulphur was added for two years but the buffer action of the soil was too strong to permit any marked change. Whereas in acid soils of TOCKLAI comparatively small additions of sulphur effected considerable change in the acidity. At Kanke, Ballia and Cuttack in BIHAR AND ORISSA permanent manurial plots were laid down to study the pH values and the nature of the exchange bases. At PUSA in two acid soils from Neterhat, Chota Nagpur, the maximum nitrification and growth of linseed plants were obtained only when twice the lime requirement of the soil, calculated by the Hutchinson and MacLennan method, was added. This year in Dacca unmanured soil, pH 5·9 and with a calculated lime requirement of 0·152 per cent., one-and-a-half times the amount of the lime requirement had to be added to produce the maximum crop of linseed. Maximum nitrification of sulphate of ammonia was found when three times the calculated lime requirement was added. In the Neterhat soil the beneficial effect of the previous year's addition of lime was still prominent. At TOCKLAI a thorough study was made of the electrometric determination of soil acidity by (1) the quinhydrone method using Veibel's standard quinhydrone half-cell, (2) the quinhydrone method using a standard calomel half-cell, and (3) the antimony electrode using any standard half cell. It appears that test solutions should be stirred while taking readings in order to get the correct pH. In the case of soils the decrease in pH resulting from stirring the solutions is often very marked. With the antimony electrode, readings even with buffer solutions were liable to fluctuations whether the solutions were stirred or not, while with soils the fluctuations were more prominent. This method was discontinued until further details on the construction of the electrode are available. It is thought that impurities in the antimony and incorrect methods for casting and polishing the electrode are responsible for the fluctuation in E. M. F. In the case of soils there is generally very little change in E. M. F. with temperature changes between 15° C. and 40° C., with few exceptions. The pH of the soil decreases by at

least 0·1 for a 10° rise in temperature. This decrease in pH has been commented on by other workers in connection with many extracts as sewage sludge and nickel-plating solutions. After a study of the variation of pH with soil-water concentration, it was decided to adopt a 7 : 5 ratio of soil to water. A large number of tea soils were tested electrometrically and compared with the colorimetric results. In the case of soil in which the colorimetric pH of the potassium nitrate extract is as high as, or higher than, that of the 1 : 3 soil-water suspension, there is no agreement between electrometric and colorimetric pH values, the former being always higher than the latter. In the case of more normal tea soils, showing a direct pH round about 5·0-6·0 and a potassium nitrate extract pH about 4·0-5·0, closer agreement between colorimetric and electrometric pH's is obtained. The effect of adding lime to an acid soil was studied both in the laboratory and in the field, and results showed that when lime is added to an acid soil, the reduction in acidity, which is great at first, becomes less and less as neutrality is approached. Half of each plot of the Tocklai lime plots was treated with sulphur in quantity sufficient to neutralise the original lime added. This theoretically should bring the soil acidity back to its original value. In every case the sulphur addition has increased the acidity to a greater extent than equivalent quantities of lime decreased it and now the acidity on the sulphured plots is well above the original figure for the untreated soil. Soils that have too low an acidity to grow tea well may be made more acid by the addition of sulphur which combines with the basic substances like lime and magnesia to form sulphate of lime and sulphate of magnesia. Owing to the high cost of sulphur, its use is practicable only on soils which are not too alkaline, and where the area to be treated is not too large. The effect of addition of sulphur to different types of soil is being studied in the laboratory and in the field. So far comparatively small additions of sulphur on the field have effected a big change in acidity, while larger doses have reduced the acidity below that tolerated by tea since on the heavily-treated plots the tea is rapidly dying out. Another important point is that even a year after completion of the sulphur

applications, there is still further reduction in acidity on both the sulphur-treated plots and those treated with sulphate of ammonia. Before making recommendations for correcting low acidity by additions of sulphur, it is necessary at present to make laboratory tests since different soils react differently to any given amount of sulphur. Sulphate of ammonia has given a marked increase in soil acidity at Borbhetta and, if its use were persisted in for any length of time on soils of the type of Borbhetta, a pronounced acid condition would result. It is, however, to be noted that as the quantity of potash and phosphate used with sulphate of ammonia increases, so there is a less tendency for the soil to change its acidity. For soils having a rather low acidity the use of ammonium sulphate provides a satisfactory method by which to increase the acidity and at the same time provide a readily available supply of nitrogen.

At PUSA it was found that the same soil shows different lime-requirements according to the method of determination employed. Further experiments were made with ten well-known lime-requirement methods on five soils, to ascertain whether the experimental determination of residual lime-requirement after a known quantity of lime was added to the soil, agreed with the calculated one. No such agreement was found, thus emphasising the fact that a lime-requirement method serves only as a qualitative guide to the soil investigator.

Soil Colloids. From experiments carried out at PUSA the Physical Chemist formulated the theory that the soil particle could be considered as a colloidal tribasic acid with three replaceable surface-active hydrogen atoms, and that the degree of dispersion and the flocculation capacity of soils depend on the nature and degree of saturation of the exchangeable ions. Bacterial activity and plant growth were conditioned by the degree of saturation of the soil colloid. Nitrification and nitrogen fixation were checked when the soil colloid was unsaturated and normal growth took place when the first hydrogen ion was neutralized. Sodium ions were not directly toxic to plants but affected adversely the physical texture of the soil. At the CALCUTTA UNIVERSITY the titra-

tion curves of sparingly soluble acids are being studied in relation to the behaviour of clay soils, and systematic colloid chemical analyses of aluminium hydroxide sol and silica sol, including the determination of the concentration of the different ions, composition of the colloid micelle and intermicellary fluid, are in progress. In BURMA an important investigation into the question why certain soils are liable to be washed away and therefore are of little value for making irrigation bunds showed that the cause of the trouble was the presence of large amounts of replaceable sodium in the clay complex of the soil. A simple test was devised whereby soils are shaken with water in the proportion of 1 to 10 for an hour after which samples are poured into test-tubes and allowed to stand. Such soils give permanent suspensions while good soils settle rapidly.

Reclamation of alkali soils. Pusa soils from a spot where sugarcane was growing very badly and from one where it grew luxuriantly, as well as alkali soils from Sakrand in Sind, were examined for their total water-soluble salts, the cations $Ca^{\cdot\cdot}$, $Mg^{\cdot\cdot}$, $K^{\cdot}$, $Na^{\cdot}$ and the anions SO_4'', Cl', CO_3''. With regard to the Pusa soil, it was found that the total salts, which exceeded 2 per cent. by weight in the top 3 inches of the bad soil, were 10 to 12 times more than those in the adjoining good soil. Sodium sulphate was the predominant constituent in the soluble salts and the amount of sodium carbonate was very small, although the soils were highly calcareous. The failure of crops in these alkali patches may be due either to the retardation of nitrification through high salt-content, or to plasmolysis of the cell saps of the young plant by the high concentration of the salt. With regard to the alkali soils of Sakrand (Sind) from the *kalar* area, the soil reaction of the whole profile shows that the medium is alkaline and that the distribution of the ions throughout would be such as to favour the formation of a solonetz soil in time. The process of solonization is characterized by two distinct phases : (1) In an alkaline medium accumulation of the salts of alkali metals takes place in the surface horizon ; (2) the second is a base-exchange process, in which calcium from the zeolite humus complex is replaced by sodium, giving rise to a sodium complex with the characteristic structure of a solonetz

soil. Exchanged cations go into solution and are washed down into deeper horizons. This results in the accumulation of gypsum in the sub-soil in the form of a hard pan. From the data obtained so far on the water-extracts of Sakrand soil, this striking tendency of the monovalent ions to rise to the surface and the bivalent ions to leach downwards has been clearly exhibited. Existence of a hard gypsum layer has also been noted at a depth of $18\frac{1}{2}''$ to $24\frac{1}{2}''$.

The *kalar* lands of SIND contain from 0·5 to 11 per cent. of soluble salts, the injurious salts commonly present being sodium chloride and sodium sulphate. In some cases magnesium chloride is also found in appreciable quantities. The nitrogen-fixing power is much less than in the salt-free soils. The reclamation experiments tried by leaching with different quantities of water and the application of chemicals like calcium chloride gave encouraging results. Frequent cropping with berseem appears to renovate such soils remarkably. At Partabgarh in the UNITED PROVINCES four methods of reclamation were in progress, *viz.*, deep ploughing in the rains with improved drainage, growing deep-rooted salt-loving leguminous crops, holding flood-water by means of bunds and mixing gravel with the soil. Similar experiments were also carried out in BIHAR and also in TRAVANCORE where the alkaline soils of the south contain a high percentage of sodium carbonate and a fair amount of calcium carbonate. Experiments at Nagercoil indicated that treatment with sulphur followed by the application of farmyard manure rendered these soils fit for rice cultivation. In the PUNJAB experiments started in 1927 to try the effect of calcium chloride and gypsum on three types of *kalar* land showed that after four years some of the treated plots gave almost the same yield of wheat as normal soil in the locality.

2. Soil fertility.

Under perennial irrigation from the Lloyd Barrage and with a much more intensive system of agriculture, the maintenance of soil fertility in the Barrage areas is a subject of the greatest importance. Hitherto, the fertility of cultivated lands has been kept up by a system of fallows which must be considerably reduced

under post-barrage conditions of irrigation and agriculture. The main lines along which this problem is being investigated by the Agricultural Department in SIND are the adoption of crop-rotations in which restorative crops occupy a large proportion, *i.e.*, fertility rotations, by conserving crop residues and waste organic matter and converting them into useful composts and by the use of green manure crops and artificial manures. A fertility rotation, " Sakrand D ", is under test at the Agricultural Research Station, Sakrand, in which 19 per cent. of the area is cropped annually with leguminous crops like groundnut, *guar*, pulses and berseem. This rotation has the advantage of being easily adapted to mixed farming where the possibilities of such a system of agriculture exist. At the same time, it is equally suited for a system based on crop production only. The data are being carefully maintained but will only be comparable when the cycle of rotation is completed, *i.e.*, after five years. At TOCKLAI, ammonium sulphate gave quick and marked increases in yield in tea directly proportional to the quantities up to the very high limit of 120 lbs. nitrogen per acre, and the use of any quantity of potash or phosphoric, or of any combination of the two together with the sulphate of ammonia, made no difference in yield whether the nitrogen was applied in one dose or in successive small doses. Plots to which nitrate of soda was applied in a number of small doses were no better than those to which the same quantities were applied in one dose. Continued use of nitrate of soda interfered adversely with the tilth of the soil and the plots looked bad because of the yellowing and blackening of the leaf, but the application of ammonium sulphate at this stage was attended with immediate good effect.

At PUSA, in the two series of rotation experiments started in 1929-30 to test the influence of leguminous crops on the conservation of soil nitrogen, three crops have been taken. The figures for total nitrogen remaining in the soil at the end of two years were less than at the beginning of the experiment. This decrease may partly be due to seasonal fluctuations as was observed in many other plots. Taking into account the nitrogen removed by the crops, however, a gain in nitrogen is noticed in all the plots.

The highest gain calculated in this way is 210·5 lbs. per acre in one series with a mixed crop of maize and *urid* (*Phaseolus radiatus*) grown in the *kharif* summer season and 177 lbs. per acre in the second series with *kerao* (*Pisum arvense*) grown alone in the *rabi* winter season. The mixed crops have given the highest economic returns, whether grown in the *kharif* or *rabi* season.

3. Nitrification.

At PUSA, when calcium cyanamide was treated with dilute sulphuric acid for two or three weeks and then added to Pusa soil, two-thirds of the added nitrogen was recovered as nitrate. No nitrate was recovered when untreated cyanamide was added. Urea was formed by the acid treatment. Treatment with alkali also results in urea formation, but only one-fifth of the nitrogen of alkali-treated cyanamide was recovered as nitrate from Pusa soil. As the nitrification of calcium cyanamide is often long delayed or non-existent when quantities large enough to add 30 mgs. of nitrogen to 100 grms. soil are taken, the changes taking place in the early stages were studied in seventeen soils from different parts of India. The results showed that in soils of pH 7·0 or more, no urea was produced and in these soils cyanamide persisted and even after many weeks incubation did not nitrify. In the soils of pH 5·0 to 6·9 there was production of urea, disappearance of the cyanamide form of nitrogen, and, except in one soil from Dacca, nitrification began after incubation for a varying number of weeks. A study of the effect of single alkali salts on nitrification showed that the concentrations necessary to inhibit nitrification were much higher than those recorded for American soils. In soil from Kalol the addition of 0·75 per cent. of sodium carbonate delayed the nitrification of ammonium sulphate and suppressed that of mustard cake. In Chinsurah soil one per cent. sodium carbonate failed to prevent the nitrification of mustard cake. The maximum amount of nitrate found was 24 mgs. per 100 grms. soil in which 0·2 per cent. sodium carbonate was added ; when one per cent. was added, the amount of nitrate found fell to 12·9 mgs. In Jorhat soils nitrification of both mustard cake and ammonium sulphate

was stimulated by additions of sodium carbonate up to 0·2 per cent. but adversely affected by higher concentrations. Nitrification in these soils was depressed by 0·2 per cent. sodium sulphate. In Pusa soil 0·2 per cent. sodium sulphate had no influence on nitrification while 0·5 per cent. checked nitrification for four weeks, after which time it proceeded normally ; and 0·1 per cent. of sodium chloride did not affect the nitrification of ammonium sulphate, but retarded that of mustard cake. Increasing doses of sodium chloride hindered nitrification, till one per cent. checked it for ten weeks, after which it proceeded slowly. With a view to see how far these results apply to alkali soils containing mixtures of these salts, two samples of *bara* soil from the Punjab and a *reh* soil collected locally were studied. It was found that in one *bara* soil the whole of nitrogen as ammonium sulphate and 80 per cent. of the organic nitrogen in cake was nitrified in eight weeks, while in the other nearly 60 per cent. of the nitrogen in cake was nitrified. In *reh* soil nitrification of ammonium sulphate was not affected by the salts, 80 to 90 per cent. of nitrogen being nitrified in eight weeks, but in the case of oil-cake, only 30-40 per cent. nitrogen was nitrified. The concentration of sodium sulphate in the *reh* soils was 0·449 per cent. in the first three inches and 0·271 per cent. in the first six inches, while sodium chloride was present to the extent of 0·047 and 0·035 per cent., respectively. In *bara* soil sodium sulphate was less than 0·034 per cent. and sodium chloride less than 0·041 per cent., but 0·03 to 0·06 per cent. sodium bicarbonate was present in these soils. In the local *reh* soils sodium bicarbonate was not noticeably present. Experiments on nitrification of crushed *til* (*Sesamum indicum*) seed, extracted of its oil to different extents, were carried out in Pusa and Kalianpur soils. In Pusa soils the nitrate accumulation was lowered by the presence of the oil to a slight extent, being only 10 per cent. less than the control. All samples containing oil from 4 to 15 per cent. gave the same decrease in nitrates. In the Kalianpur soil the amount of nitrogen nitrified in the presence of 4 per cent. oil was 15 per cent. lower than in the control ; but with higher quantities, *viz.*, 12 per cent. and 15 per cent. of oil, the amount was lowered by 32 per cent.

This difference in the effect of the oil in the two soils is attributed to the difference in the lime content, 30 to 40 per cent. in Pusa soil and less than 2 per cent. in the Kalianpur soil.

At TOCKLAI, in continuation of work done in past years in connection with nitrates and ammonia in the soil, a further series of plots were examined weekly. January and February were dry but during March when good rain is normally expected only a few showers fell which were insufficient to penetrate into the soil. From April 18th heavy and continuous rain fell till the end of the month. The highest figure recorded for nitrates in the unmanured plots was 4 parts per million as against an average of 15 parts per million throughout April 1930. The figures for the manured plots were correspondingly low. It is to be noted that in spite of the low nitrates, recorded crops for this season were better than in 1930. Manures were applied on the 16th April ; 6 days later on the morning of the 22nd, nitrates had reached a high figure of 26·5 parts per million. Two-and-a-half inches of rain fell that night and another 4·2 inches before the morning of the 29th. When the next sample was taken it showed only a moderate nitrate content of 5·2 parts per million. From this time onwards the nitrate of soda plots were no richer in nitrate than the unmanured plot. The total crop for the season from the nitrate of soda plot was approximately 23 per cent. higher than from the unmanured plot. In October a significantly larger crop was obtained from the nitrate of soda plot. This seems to indicate that an increased food-supply persisting in the soil for a very short period can produce increased crop long afterwards. Heavy rain falling just after the application of the manures may have caused soluble forms of nitrogen in the sub-soil to play a more important part than usual. Both nitrates and ammonia were relatively high at least down to 3 feet on the manured plots (sulphate of ammonia) which were regularly sampled below the surface. To determine whether there was any concentration of nitrates at lower depths on the nitrate of soda plots which had shown such a rapid disappearance of nitrate from the surface soil between the 22nd April and 6th May, these plots were sampled down to 3 feet

from the 30th May onwards. Between the 13th May and 11th June, there is a considerable concentration of nitrate at 3 feet deep, compared either to the unmanured or to the sulphate of ammonia plots. There is not during the season any indication of nitrate returning from the deeper subsoil to the surface, except possibly during the period May 27th to June 4th, but this was the only period of time when the soil was dry, otherwise rain fell continuously up to August 13th so that percolation downwards must have been continuous. The natural nitrifying power of a soil from one of the cultivation plots has been determined weekly, to find whether the rate of increase of nitrate under standard conditions may be taken as a constant for a given soil in an air-dry condition. The results are satisfactory, but when the initial nitrate of the soil is high (as in April) a complication occurs. Thus, while the initial nitrate of the soil in question lay between 2 and 20 parts per million, the soil was capable of increasing its nitrate by roughly 10 parts per million in two weeks. The natural nitrifying power of this soil is therefore taken as 10, which appears to be a reasonable figure for a soil of moderate fertility. When, however, the initial nitrate had risen to the region of 30 parts per million further nitrate production did not occur, and in some cases a loss resulted on incubation. It therefore appears that there is a definite maximum nitrate figure for soils not under the action of fertilizers, and analyses of Red Bank soils have shown that this figure varies with different soils. A special interpretation of natural nitrification figures may be necessary when the initial nitrate is high, and in general it would be preferable to determine the nitrifying power of a soil on a sample taken during the rains. In a carefully designed experiment in COIMBATORE, green manure, cattle manure and ammonium sulphate were applied at such a rate that the nitrogen-content of the soil was increased by 30 parts per million of dry soil and cotton was grown. The results of analyses of fortnightly samples showed the presence of nitrates to a depth of 3 feet, and that active nitrification was occurring only in the first foot layer of the soil. A decrease of nitrate in the surface foot of the soil is not accompanied

by an increase in the second and third foot layers of the soil, and this indicates that no downward movement of nitrates was taking place. Although the concentration of nitrogen in the cotton plant is greatest in the early stages of the plant, the crop made large demands on soil nitrogen from about the end of October to the end of December—a period of rapid vegetative growth. The absorption of nitrogen was more steady in the plots receiving organic manure than in the plot receiving ammonium sulphate where the curves for nitrate nitrogen show more violent fluctuations. The disappearance of nitrate nitrogen either in the cropped or uncropped plots may be explained on the score that it was being utilized by the crop or was being converted into insoluble forms of nitrogen and held in the soil. But an examination of the figures for total nitrogen shows that nitrogen is being actually lost in varying amounts from the different plots. The presence or otherwise of organic matter and the dynamic equilibrium ratio of carbon to nitrogen appeared to determine the loss or otherwise of nitrogen.

At PUSA the organic nitrogen and nitrate nitrogen at different depths were determined on manured plots, and large increases of nitrate were found where green manure had been applied and especially where it was used in combination with superphosphate.

4. Manures and Fertilizers.

Manures. In connection with all kinds of field experiments, improved methods of lay-out, involving the technique of randomization and replication of plots and statistical study, have in recent years enabled the experimenter to take account of the effects due to soil variation and to estimate the degree of reliability based upon errors due to chance, so that it has now become possible to deduce satisfactorily the full implication of differences between different treatments. This has led to a more correct interpretation of results in all field-experiments on varietal, cultural and yield tests and nowhere has this been shown to better advantage than in manurial experiments. Mention has already been made in Chapter 1 of the work of the Fertilizers Committee of the Imperial Council of Agricultural Research. The most necessary factor to maintain

and improve soil fertility is the existence of sufficient humus in the soil for which a steady supply of organic matter is imperative. The results of the permanent manurial plots at COIMBATORE conducted for over twenty years, though unreplicated, show that farmyard manure possesses advantages in the matter of yield as well as quality of the crop obtained, over mineral manures. As regards yield, it is stated that though artificial fertilizers show superiority over farmyard manure in some cases in the earlier years of their application, in later years, farmyard manure asserts itself in contributing to greater yields and that mineral manures are capable of being better utilized in the presence of sufficient supplies of organic matter than when applied alone. These results are corroborated by the permanent manurial plots on wheat and maize in the CAWNPORE FARM manured from 1883 to 1913 and unmanured since then, where the direct and residual effects of cowdung, sheepdung and poudrette have been found definitely superior to saltpetre or saltpetre plus bone-superphosphate. As regards quality of the crop, results in Coimbatore show that the seed obtained on the cattle-manured plots possesses higher nutritive value than that raised with mineral manures. Apart, therefore, from the indirect benefits conferred by organic manures on plant growth in improving the texture and water-holding capacity of the soil and in providing food for soil bacteria, organic matter appears to give the plant a better balanced nutrition. A series of experiments at PUSA indicated that the addition of 1 to 2 per cent. of superphosphate to cow or bullock dung greatly diminishes the loss of nitrogen during ten months' storage and a much higher percentage of nitrogen becomes recoverable as ammonia from the dung plus super mixture than from dung alone. There is, however, little hope of large quantities of cattle manure becoming available until an alternative source of fuel comes into general use and some form of mixed farming is generally adopted. The most promising alternative sources of organic matter for the soil are composts, green manures and oil-cakes.

COMPOSTS. The composting of waste materials like sugarcane and plantain trash, prickly-pear, groundnut husk, leaves of coconut

palms and other trees, stalks of gingelly, cotton and pigeon pea, water-hyacinth weeds, village sweepings and other vegetable useless matter has been carried on by most departments of agriculture, and much progress has been made in inducing cultivators to take up the practice. This artificial farmyard manure has given in many places as good yields as the natural stuff. A review of the recent experiments on its preparation was published in Vol. XXV of the *Agricultural Journal of India*.

GREEN MANURE. The benefits of green manure too are well established and experiments are now carried on with a view to find the best plant for particular localities. In PUSA sann-hemp and a relative *Crotalaria servicea*, Mexican sunflower, soy bean and *urid* did well, with and without superphosphate, for sugarcane, wheat, potatoes and onions. In MADRAS the use of green manure in conjunction with superphosphate and bonemeal for rice is extending rapidly and is found to be very efficient, better than all manures excepting oil-cakes and superphosphate alone. The usual plants used are *dhaincha*, sann-hemp, indigo and *Phaseolus trilobus* and the extra yield is from 15 to 20 per cent. At the Kumpta farm in BOMBAY, *Nux vomica* and *Terminalia paniculata*, in combination with bonemeal, have increased the yield of rice in the husk by 149 and 94 per cent., respectively, over the check farmyard manure plots and this has happened for three years. At Shahjahanpur in the UNITED PROVINCES the green-manured plots gave an extra yield of 250 maunds per acre of Co. 213 and 275 maunds of Co. 243, which at current prices came to Rs. 94 and Rs. 104, respectively. In the CENTRAL PROVINCES sann-hemp with superphosphate and in BIHAR AND ORISSA *dhaincha* with superphosphate are considered the best manures for rice. At Mudon in BURMA *Centrosema pubescens*, *Colopogonium mucunoides*, *Candida* and *Crotalaria anagyroides* were found to suit the local conditions.

OIL-CAKES are used on profitable crops like sugarcane where other forms of organic matter are in defect. In PUSA in an experiment with oil-cake and sodium nitrate and combinations of both, the highest returns were got with 15 to 20 maunds of oil-cake per acre ; sodium nitrate in addition to, or in part replacement of, oil-

cake, had no advantage. In experiments at SAMALKOTA the average of the last four years showed that on first-crop rice an increased yield over no manure of 7·4 per cent. was secured with castor-cake alone and of 16 per cent. with castor-cake and superphosphate, while on second-crop rice increased yields of 13 and 85 per cent., respectively, were secured.

BONE MANURE. At the instance of the Fertilizers Committee, several provinces have undertaken an investigation regarding the disintegration of bones. The results of the work at PUSA on treatment with superheated steam with easily available chemicals and by fermentation in composts were published in March 1931, in *Agriculture and Livestock in India*. At Poona, by means of a grant from the Sir Sassoon David Trust Fund, the Agricultural Chemist has tried a number of treatments and analysed the nitrogen and phosphoric acid available. Bonemeal is having an increasing use for rice fields in Madras, on the acid soils of Kumpta in Bombay, in Bihar and Orissa, in the Central Provinces and in Burma.

Fertilizers. Expreiments conducted at Coimbatore showed that sodium nitrate increased rice yields by from 15 to 20 per cent. but in comparative trials it was inferior to green manure, while laboratory investigation on the nature of its action showed that it was more physical than biological. At Lyallpur it was found to be of distinct value for wheat after wheat, 123·4 lbs. of the manure giving during three years 21·3, 21·5 and 43·5 per cent. increases over no manure.

Calcium cyanamide did rather better than ammophos at Pusa on maize followed by oats; and on the acid soils of Kumpta in Bombay it gave a very good response. In the light loam of the Lyallpur farm, where the soil fertility was poor, it gave high yields, 123·4 lbs. of the manure giving during three years increases of 90, 60 and 41 per cent., respectively, over no manure.

Ammonium sulphate in combination with superphosphate did well on rice in Samalkota and, in combination with groundnut-cake, on sugarcane. Alone it was found to be a suitable manure for rice on the trap soils of Karjat in Bombay where it gave from 40 to 50 per cent. of increased yield over no manure. Experiments on

cotton at Lyallpur carried on for four years provided fairly strong evidence that a top dressing of ammonium sulphate about the end of August increases the yield and these results agree with those of experiments at Surat. Ammonium phosphate of various types was of value as a top dressing on most crops in Bengal.

The use of phosphatic manures alone or mixed with other artificials and organic manures, or supplemented by green manure, is now becoming popular in several provinces. Superphosphate is found to be of particular advantage to rice, cane, tea and rubber and is being largely used in the Madras Presidency. In Coimbatore Central Farm, the soil of which is not deficient in any of the elements, superphosphate mixed with cyanamide showed an increase on rice of 23 per cent. over control, while in Hagari, with its black soil poor in nitrogen and phosphoric acid, ammonium sulphate (164 lbs. plus superphosphate 82 lbs.) increased the yields of sorghum by 146 per cent. and those of cotton residually by 90 per cent. But the soils and crops in India seem to require a judicious combination of nitrogenous and phosphatic manures, and this explains the increasing popularity of compound manures like ammophos, diammonphos and leunaphos. In North Bihar ammophos (14-20) at 3 maunds per acre has proved useful for sugarcane, while in south Bihar niciphos is better. In Burma the residual effect of fertilizers on rice is shown to be significant in the case of diammonphos, superphosphate and lime. An experiment to determine the optimum dressing of leunaphos shows that the best return, from the small cultivator's point of view, is obtained from a dressing of 50 lbs. per acre with an increase in grain of 38 per cent. The maximum profit, on the other hand, was obtained from a dressing of 200 lbs. which gave an increase in grain of 92·5 per cent. When the fertilizer was applied to land covered with water 4 to 6 inches deep, there was a much smaller increase of grain. For the best results, the fertilizer must be applied immediately before transplanting and be thoroughly worked into the soil. The interesting experiment was made of top dressing paddy, badly attacked with *Sclerotium oryzae*, with leunaphos at 100 lbs. per acre. Within a week there was a striking difference between the treated and

untreated plots. Within a month the former had grown much in advance of the latter and showed no external signs of disease. At harvest the treated plot showed a net increase of 80 per cent. of grain and an increased profit of Rs. 19 per acre. Top dressing evidently has great possibilities. Further work has shown that the 20-50 grade diammonphos is likely to exert a better residual effect after the first year than the 20-20 grade, but that the latter is to be recommended in most areas for giving a quick return in the first year. Applications of fertilizers of the ammonium phosphate type are not yet to be recommended for regions of high rainfall like Arakan and Tenasserim where, it appears, the fertilizer is partly lost by flooding and erosion. The officers of the department during the last ten years have conducted careful and elaborate experiments on all the central farms and especially on those dealing with paddy, to determine the best fertilizers, the correct amounts to apply, the best methods of application, and the frequency with which they should be applied. The results at Hmawbi, Mandalay and other stations were most promising and when the price of rice was standing at Rs. 160, substantial benefits were obtained from the use of these materials and several agencies for their sale were opened in Rangoon. In Mysore, too, practically all the crops experimented with, *viz.*, coffee, cotton, sugarcane, coconut, arecanut, rice, *ragi*, *jowar* and cotton, responded to the use of nitrogenous and phosphatic manures and the most striking results were obtained from the readily available forms of artificial fertilizers. The fall in the price of these crops, however, by nearly 50 per cent. in one year has put a different aspect on the matter, for the fall in the price of fertilizers has been not more than 10 per cent. in the same time. Unless conditions improve, commercial fertilizers cannot be used profitably except on a comparatively small number of crops like sugarcane and coffee with rice on the border line. All that the departments can do, therefore, in the meantime is to continue their experiments and collect as much data as possible.

5. Water requirements of crops.

At ANAKAPALLE RESEARCH STATION experiments have been in progress for the past four years to find out the minimum amount

of water that is necessary to raise sugarcane. The quantity of water used by the ryots is much in excess of requirements and this restricts the time at which the crop is cultivated only to periods when water is available in abundance. Experiments at the station have conclusively proved that with Co. 213 cane, provided the land received a deep cultivation and hoeing to start with, the number of irrigations could be reduced to one, with better yields of jaggery, the number of irrigations usually given by the ryots being 5 to 10. At the SAKRAND RESEARCH STATION in Sind, two varieties of wheat, Pusa 12 and C. Ph. 47, were tried with different quantities of water and the yields indicated that C. Ph. 47 gave as much yield with 12·8 acre inches of water as Pusa 12 would give with 16·5 acre inches of water. Given the same quantity of water, the Sind wheat was capable of giving a higher yield than the Pusa variety.

Important experiments on the duty of water for paddy under tank irrigation have been in progress in MYSORE for five years and were brought to a close in 1929-30. Six separate crops were tried and the results showed that though the rather wasteful application of water which is now taking place gives a somewhat higher yield, a very much more economic utilization of water is possible. For instance, with reference to paddy, it has been shown that by doubling the supply of water, only about 9 per cent. increase in yield was obtained, showing that same amount of water could be utilized for irrigating twice the area with profit.

6. Agricultural meteorology.

The general relationship between weather and agriculture is probably more widely recognised in India than elsewhere. Apart, however, from the recognition of the general relationship, there is very little exact knowledge about the true relationships, *e.g.*, about the amounts of rainfall that are effective and about the times when rainfall, sunshine, temperature and humidity are beneficial or harmful. It is also obvious that if satisfactory correlation between weather conditions and crop yield and crop areas can be established, crop forecasting will be improved. The Imperial Council of Agri-

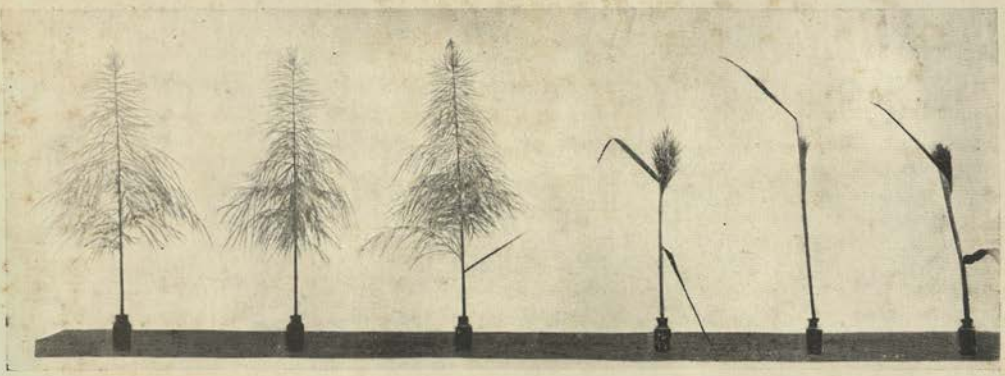
cultural Research sanctioned a grant to establish a Branch of Agricultural Meteorology to be temporarily attached to the head-quarters of the Meteorological Department at Poona. Besides the statistical and routine side, work has begun on the research side where the proposal is that the investigations should first aim at selecting (in consultation with agricultural workers) the best methods and standardising them for the measurement of radiation, evaporation, soil temperature and soil humidity, so that these data may ultimately be systematically maintained, in addition to those of air temperature and air humidity, rainfall, wind, sunshine, etc. The other research problems will mainly be concerned with the question of "effective" rainfall, the meteorology of the air layers near the ground and the flow of heat and water through the ground surface (a branch of work which will come in contact with the physical chemist's); there will also arise opportunities for joint work with biologists and mycologists, *e.g.*, on the effect of varying meteorological factors on plants, fungi, insect pests, etc. By investigating methods and devising instruments, the agricultural meteorologists will be able to render considerable assistance to work already in progress at certain experimental stations such as the Sakrand Agricultural Experiment Station in Sind, the Cotton Research Institute at Lyallpur, and the Pusa Research Institute.

7. Plant-breeding and genetics.

In these days of advanced methods of agriculture when only the best and most productive strains of crops interest producer and consumer alike, plant-breeding is of primary importance. Results in this work have achieved surprising success and the productivity on a given acreage both as regards amount and quality would amaze cultivators of a by-gone and less enlightened age. Every province has its plant-breeder and some have several, all engaged in breeding strains for particular purposes of the staple crop plants of the province. Plant-breeding work has, as a rule, three stages, the isolation of the different strains which go to make up the local mixture, the identification of the different characters found present and a study of their inheritance, and lastly, the crossing of one strain

with another with the object of obtaining strains of higher economic value. Besides evolving good quality high-yielding strains, the plant-breeder has of recent years concerned himself with evolving strains having disease resistance. Diseases on most crops in India are so diverse and frequent and their cause so difficult to understand by the growers who have come to look on them as visitations of Providence, that this line of work of the plant-breeder enables the grower to secure the benefit of better varieties in all years. Frequent reference to individual cases has been made in Chapter 1, where under the various crop headings a good deal has been said about the economic successes, but a few more activities remain to be mentioned. The classification of local rices and the inheritance of characters of rice has been studied in Pusa, Madras, Bombay, Bengal, the United Provinces, Assam and Mysore. The characters of the cotton both in relation to its flowering period and position on the plant, the inheritance of floral colour and the variation of lint length were studied in Madras and Bombay, and general breeding in the Punjab, the Central Provinces and Mysore. Wheat-breeding has gone on in Pusa, Bombay and the provinces of Northern India. At Pusa a classification of types of barley was made preparatory to breeding operations and hybridization of oats was studied. At Coimbatore, work was done on *jowar*, *bajra* and *ragi* and at Pusa on the varieties of gram. From Pusa came a paper on the improvement of Indian cigarette tobacco by hybridization and one on the study of sex in hemp. At this station the plant-breeding of linseed, hemp, chillies, and *Hibiscus* was in progress. Both in the Central Provinces and in Pusa was a study of pigeon-pea carried to a definite conclusion. A start was made in coffee-breeding in Mysore and the first authentic cross between *arabica* and *robusta* was planted out. Both in Mysore and Coimbatore breeding of varieties of sugarcane was in progress, also in the latter place the pollen-grain and ovary of sugarcane before and after fertilization were studied. In Coimbatore too the most interesting and valuable cross between sugarcane and *jowar* was made in 1929. The cane parent was P. O. J. 2725 and the *jowar* parent the variety known as Periamanjal (Plate I). Useful combinations are rarer even among these hybrids

INFLORESCENCES OF SUGARCANE × SORGHUM HYBRIDS.



P.O.J.2725. P.O.J.2725 × Sugarcane. P.O.J.2725 × Sorghum. Sorghum.

P.O.J.2725. P.O.J.2725 × Sorghum Hybrid No. 50. Sorghum.

Reproduced from the Scientific Reports of the Imperial Institute of Agricultural Research, Pusa, 1930-31.

than they are among cane seedlings where they are by no means common. The more vigorous of the hybrids which matured in 6 months were analysed in the second year and the juice analysis is given in the following table :—

Juice analyses of sugarcane-sorghum hybrids, six months old.

Seedling No.	Brix per cent.	Sucrose per cent.	Glucose per cent.	Co-efficient of purity.
Co. 351	20·42	18·53	0·17	90·8
Co. 352	19·31	17·33	0·26	89·6
Co. 353	19·01	16·75	0·42	88·1
Co. 354	18·38	16·18	0·41	88·0
Co. 355	17·71	15·22	0·58	85·9
Co. 356	18·51	16·11	0·50	87·0
Co. 357	20·15	18·00	0·18	89·3

Already the progeny of this cane-*jowar* cross has shown that early-maturing canes with a high sucrose-content will be available which may enable the sugar mills to begin operations each season a month earlier than they can do at present and that more nutritious and palatable fodder *jowars* may be evolved.

8. Plant physiology.

At Surat a scheme financed by the Indian Central Cotton Committee set out to discover the causes of the large amount of shedding of buds, flowers and bolls in the cotton plant and a very considerable amount of knowledge about the physiology of the cotton plant has been recorded though no method has been discovered by which the shedding would be reduced. In the Punjab the investigation of the periodic failure of Punjab-American cotton has been going on for some years. The Cotton Research Botanist has written two papers on the physiological response of the cotton plant to its environment.

He says that the experimental evidence shows that, during the development of the cotton plant in the Punjab, the surrounding climatic factors may produce unfavourable reactions in the plant. In some years the effect of certain conditions, or the accumulated effect of a succession of unfavourable conditions, is sufficiently severe to produce a general pathological state in the plant, which shows

itself eventually in the failure of the bolls to open properly. The cause of this lies in the depressant effect these factors have on root development, particularly in the early stages. Where root-growth is satisfactory, a good crop can be matured, and where root-growth is restricted, the bolls open badly. Convincing examples of this were found in the 1928 and 1929 root-restriction experiments. The root development of the plant exercises a preponderating influence on the good or bad nutrition of the bolls and, therefore, on their subsequent good or bad opening. From the daily records, he states, it was found that no one climatological factor could be held solely responsible for failures, but that each year a number of unfavourable factors operate at different times, and that it is the cumulative effect of these which is capable of causing failures. The Cotton Research Botanist believes that among the major factors which may operate are the following: an excessively hot and dry spell in the early part of the season, an abnormal number of dust-storms, puddling or water-logging of the soil due to heavy falls of rain, and late non-dehiscence of anthers, producing as a final result an undue competition between boll and boll for available nutrients, and also severe white fly attack consequent on a weakened resistance of the plant due to earlier unfavourable conditions.

There are, he thinks, other minor factors which prevail at different times and which co-operate with the major factors in destroying the crop. Various methods of ameliorating these conditions are suggested. For example an alteration in sowing date, good cultivation, and good agricultural practice. In the Punjab, he says, even under irrigation conditions, the climate is an arid climate, and it must be realised that the principles of dry-farming require to be applied. Consequently, the storing of water in the soil and the taking of every precaution to prevent water-loss from the soil are necessary. Also the reduction of weeds, green-manuring and, perhaps most important, suitable fertility-restoring rotations are all useful and desirable. It is, however, probable that the only really effective means of removing the possibilities of failures will be in the discovery of a type of plant which is constitutionally fitted to withstand the vagaries of climate and which can be relied upon

to produce, even under extreme conditions of environment, a properly nourished boll.

The following three investigations were carried out with the help of grants from the Imperial Council of Agricultural Research. A study of the physiology of the water-hyacinth was undertaken at Cuttack. It was found that seeds require a period of dryness before germination but if the testa of mature seeds be mechanically ruptured, the seeds germinate at once. It appears that seeds remain viable for four years. At the Royal Institute of Science, Bombay, the physiology of the rice plant was studied so far mainly with a direct view to cultivation, and the work done centred mainly on the manurial requirements of the plants. Valuable information has been collected on this particular topic. The osmotic and suction pressures were measured throughout the life of the plant, also the rise in those pressures on the addition of ammonium salts to the soil. Quantitative data have been collected about the intake of ammonium salts and the absorption ratios calculated. The photosynthesis, respiration and transpiration were also measured. Research on the effect of different ions on plant growth was begun at Lahore and so far the results indicate that a number of metallic ions, when added in the form of nitrates, affected the growth of the plants appreciably. Salts of uranium, thorium, cerium and iron showed an increased growth while those of lead and silver were found to have an adverse effect on growth.

A branch to study the physiology of tea was opened at Tocklai in the Scientific Department of the Indian Tea Association, and the work consisted mainly of collecting material, but it has not yet been found possible to examine all of it or to co-ordinate the data obtained. Work was also done to ascertain the distribution of tannin within the tissues of the plant. In this case a method had to be devised for fixing the tannin within the tannin-bearing cells before the material is prepared for microscopic examination. After a considerable amount of work, a successful method has at last been devised, and the results obtained by this method seemed to be considerably in advance of those obtained previously.

9. Plant diseases.

Rice. In MADRAS the investigation of blast caused by *Piricularia oryzae* was continued under four aspects : varietal resistance, the effect of manures, the effect of irrigation and morphological and histological studies. Among the fourteen varieties included in the trial, three have in three seasons exhibited a very high degree of resistance while the local rice and two other selections were found to be highly susceptible. An erect flag, a short neck, a compact panicle and an abundantly hairy ligule are factors associated with fungus attack. Indications were also obtained to show that the greater frequency of vascular bundles and the larger distribution of sclerenchymatous tissue were associated with disease resistance. Plants that received heavy doses of nitrogen were the first to succumb. Potash and phosphate showed slight inhibitory effect but not enough to save a susceptible variety. The effect of a restricted water-supply against ample irrigation was not significant. A foot-rot caused by *Fusarium* (*Cephalosporium*) on seedlings in the nursery was overcome by treating the seed in a 2 per cent. solution of copper sulphate for 30 minutes.

Wheat. A new bunt of wheat (*Tilletia indica*) was discovered by Dr. Mitra of PUSA. It occurred at Karnal in the Punjab on several varieties, both hybrids and their parents, among which were Federation and Punjab 8A. It was found to be fairly common in the grain of 8A stored in the Lahore grain market, so it is likely to occur in other localities in the Punjab. It is not easy to detect infected from sound plants, as the smutted grain remains enclosed in the husk. Usually it is only on being threshed that the smutted grains become evident. All the grains in an earhead are not usually infected and the disease does not at present seem to do very much damage. A sample of infected seed produced smutted plants in Karnal but not in Pusa, nor did artificially infected seed in Pusa. Besides the two species of *Helminthosporium* already known on wheat in India, a new species *H. vicolor* and a new variety of *H. halodes* were found from Poona and the other from the Central Provinces. In 1930 the variety P. 4 had 37 per cent. of its leaf-surface destroyed while the others ranged from 20 per cent. downwards to 3

per cent. Again in 1931 varieties P. 4 and P. 111 had twenty per cent. destroyed while P. 12, P. 52, P. 101, P. 163 and country wheat had three per cent. or less.

A survey of rust was made on all the varieties of wheat grown at PUSA. In 1930, P. 12 had 15 per cent. of its leaf-surface destroyed by orange rust, P. 80-5, P. 112, P. 111, P. 4 and P. 114 had from 7 to 3 per cent., while P. 52, P. 113 and Federation were free. As for yellow rust, P. 113 had 17 per cent. and P. 52 five per cent. destroyed and the rest were free. Black rust was severe on P. 12. The year 1931 was a light rust year. Pusa 12 and Pusa 4 had 11 and 9 per cent. of leaf-surface destroyed by orange rust, while the others had little or none. Yellow rust was 8 per cent. on P. 161, 4 per cent. on P. 162, 2·5 per cent. on P. 115 and P. 163, and only in traces or was absent on the others. Black rust appeared late and was present only in traces. At Karnal, on the other hand, P. 52 and P. 115 were so badly rusted that the grain was badly shrivelled.

The investigation of rusts on wheat, carried on at Allahabad and Simla under the auspices of the Imperial Council of Agricultural Research, has made considerable progress. It is now fairly well substantiated that uredospores of rust come from the Himalayas in the north and begin the attack each season in the plains of Northern India. There is also evidence that a similar thing happens in Peninsular India and that the uredospores come from somewhere in the Western Ghats. Overwintering occurs in the hills at fairly well defined levels for each of the three rusts, *e.g.*, yellow rust at higher altitudes, orange rust at intermediate altitudes and black rust at from 3,000 to 4,000 feet. Preliminary investigation seems to show that the number of physiological forms of rust on wheat are few. This investigation will provide most valuable information to the wheat-breeder.

A simplified hot water treatment for the control of loose smut has been successful in the Punjab in preventing this disease and was demonstrated.

In the CENTRAL PROVINCES black-tip and foot-rot, caused by species of *Helminthosporium* and *Ophionbolus*, causes loss of varying

severity in different years. Forty-seven samples of wheat from farms in the province showed the presence of infected grains except in three samples and the percentage varied from 0·6 to 34. Germination was not affected even when the blackening extended beyond the embryo. The hyphae were found to be confined to the pericarp whence they spread to the first colourless leaf of the seedling and, when climatic conditions were favourable, the fungus spread to the roots and stems killing the seedling. Experiments continuously proved that the earlier the wheat is sown the greater the incidence of the disease. So it would appear to be best to delay sowing after the monsoon, till there is a drop in the air temperature. Plots sown as late as the first week of November gave as good yields in grain as those sown about the 20th of October.

Barley. The barley varieties grown in PUSA showed varying susceptibility to the leaf-spot caused by *Helminthosporium sativum.* A similar leaf-spot caused by *H. teres* was seen in Pusa for the first time, possibly introduced in seed from England or Nepal, and did more damage to the leaf-surface than the other one.

Cotton. In MADRAS the intensive study of the herbaceum cotton boll-rot and seedling blight caused by *Colletotrichum* was continued. Two weeds of the black-soil, *Aristolochia bracteata* and *Hibiscus ficulneus* were found to act as alternative hosts of the fungus. The eradication of these weeds may prove one of the means of controlling the disease. Following Ludwig's experiments in South Carolina on the control of cotton anthracnose, it was found that moist storage inhibited the disease but the seeds became musty and germination was poor. Dry storage did not reduce the disease but alternate dry and moist storage did reduce it. An attempt will now be made to test the utility of the method. Of six of the Cotton Botanist's strains tested one showed a high degree of resistance.

At Dharwar in BOMBAY attention has for several years been paid to the wilt disease. The nature of resistance to wilt in the cotton plants is not due to any peculiarity of structural differences in the roots of susceptible and resistant types for, while penetration of the fungus is common to both, its further progress in the susceptible

host is unhindered but is checked in the resistant one. The investigation has shown that the fungus is borne inside the seed and that fact indicates that in an organised seed distribution care must be taken not to take seed from a wilt-infected area to a wilt-free area that might be suited to the establishment of the fungus. This is in consonance with the experience in Texas where the state authorities have already taken action prohibiting the distribution of cotton seed from wilt-infected areas.

In the CENTRAL PROVINCES a physiological study was made of cotton *Fusaria* from Dharwar, Egypt and U. S. A., and the results so far obtained confirm Fahmy's conclusion that the three *Fusaria* are different. The seedling blight of cotton in these provinces rivals wilt in the damage it does. The cause was found to be *Rhizoctonia bataticola*, but *Rhizoctonia Solani* and *Pythium aphanidermatum* were also present. The varieties, Roseum, Buri and Verum 262 showed different percentage of alumina at different stages of growth. In plants two-months-and-a-half old, the percentage of alumina in Buri and healthy Verum is much more than in healthy Roseum; as the plant grows there is a decrease in the alumina percentage in Buri and Verum, but an increase in Roseum. In young diseased plants of Verum 262, two-and-a-half months old, there is no marked increase in the alumina percentage; but in old diseased plants, four-and-a-half months old, the alumina percentage is much higher than in healthy plants of the same age. In young diseased plants of Roseum, two-and-a-half months old, the alumina percentage is about twice that in healthy plants of the same age; in old diseased plants of Roseum, four-and-a-half months old, the alumina percentage is higher than in healthy plants of the same age but the increase is not so much as in young diseased plants. From this analysis it is seen that the resistant varieties, Buri and Verum 262, when two-and-a-half months old, have practically the same alumina percentage as Roseum plants four-and-a-half months old. Whereas in the resistant varieties there is a decrease in the alumina percentage when they are four-and-a-half months old, in Roseum, a susceptible variety, there is an increase.

Sugarcane. The study of mosaic disease was continued at Pusa, in the Punjab, the United Provinces and Madras. Rogueing at Pusa for five years on 40 acres containing a large variety of Co. canes reduced the incidence, so that in 1930-31 only ·002 per cent. of clumps were infected except in two plots of Co. 205 where the percentage was 0·8. Fortunately this very susceptible cane has been discarded because, in addition, it contains too much fibre, and Co. 285 is taking its place. Cane is not ratooned at Pusa. Rogueing is being done with some success in the United Provinces and the Punjab. In the Punjab and Madras, unlike Pusa, mosaic spreads rapidly. In 1930 in the Punjab, mosaic-free canes introduced into Lyallpur in April became 80 per cent. infected by October. Of 19 varieties of cane at Coimbatore Co. 205, Co. 214, Co. 244, Co. 314, Co. 315, Co. 316, Co. 318, Co. 335, P. O. J. 2878, Kassoer and P. O. J. 2714 showed either complete freedom from disease or a very high degree of resistance. The examination of the cuticle of three varieties, Co. 205, Co. 213 and Co. 223, did not show correlation between cuticle thickness and resistance. It was observed that secondary infection took place between the second and fourth months and gradually decreased till the seventh month after which it ceased altogether. A field experiment was laid down in 1931 to see whether there is loss in tonnage.

In 1930-31 an experiment in Pusa showed that the loss in tonnage of mosaic-infected cane was 4·6 per cent. in Co. 213, the most popular cane, and 8·6 per cent. in Co. 205. The quality of juice was slightly lowered in Co. 213 but did not show in Co. 205. Next year a similar experiment showed that the loss in tonnage of Co. 213 was 14·8 per cent. and the quality of the juice was again slightly lower. An examination of the Co. canes in North Bihar showed that infection on Co. 213 was only 0·2 per cent., so that so far the loss due to mosaic in this locality is very small. A similar experiment at Lyallpur showed that the healthy crop yielded 21 per cent. cane, 17 per cent. juice and 21 per cent. *gur*, more than the mosaic infected cane. This is a much larger difference than at Pusa.

A study of *Helminthosporium sacchari* at Pusa showed that it consists of several strains and saltants. This line of work is being

followed up to compare them with disease causing *Helminthosporia* in other countries. The strains and saltants cover a range sufficiently great to include, so far as the spore size is concerned, all the forms of *Helminthosporium* causing eye spot.

Smut is now almost absent from the farm at Pusa, only 7 cases being found in 1930. Through careful selection at planting time red-rot has been eliminated from the farm, not one case has been seen in 4 years. No fresh case of downey mildew has been found since the single case of 1929. The fungus infected cane, maize and *Euchlaena luxurians* artificially.

Millets. A species of *Striga* did considerable damage to *jowar* in the Central Provinces and it was found that some varieties were little affected whereas others were completely wiped out. Attempts to destroy this flowering parasite by ploughing at various times and by burning stalks of cotton and pigeon-pea on the field were not very successful. Early sowing in July, however, gave good results as compared with late sowing in that month.

Ragi. Two related fungi causing leaf-spot, seedling-blight, head-blight and foot-rot of *ragi* were found at Pusa to attack also wheat, oats, barley, *jowar*, *bajra* and grasses.

Potatoes. The efforts to reduce storage rot have been mentioned in Chapter II. The mosaic disease is a serious menace to the potato crop of the UNITED PROVINCES. Being very little understood by the cultivator, it has attained serious prevalence in his fields. The results obtained at the Research Farm conclusively show that this serious malady may be easily controlled by thorough and careful rogueing and selection of seeds only from healthy hills. By this method the disease has been fully controlled at the Research Farm and has been brought down from about 70 per cent. in the course of four years, till in 1931 the crop from seed raised here gave perfectly healthy crop wherever grown. In MYSORE a promising start was made in the control of the Altermaria blight, a serious disease in the potato-growing areas of the State by means of Bordeaux mixture.

Beans and pulses. The selection of wilt-resistant strains of *rahar* at Pusa was successful. It was hoped to get an immune strain

but that may come yet. In the season 1929-30, seed of the resistant Type 80 was sown in the fourteen plots of the Permanent Manurial Series B, and in 1931-32 of Series A. The average number of wilted plants in each plot for the previous six seasons in which *rahar* was grown there, also the number in each plot during the immediately previous season and the number of wilted plants of the resistant type are given in the table below. As the number of wilted plants in the previous season (1927-28 and 1928-29 respectively) is much less than the average for the six seasons, it may be more reasonable to compare it with the result of those seasons. Summing all the wilted plants, it is seen that the totals of wilted plants are in the proportion 100 : 3·6 and 100 : ·05, respectively.

Number of wilted plants.

Plot	B.—SERIES.			A.—SERIES.		
	Mixed farm seed	Resistant type T. 80		Mixed farm seed	Resistant type T. 80	
	Plot average	1927-28	1929-30	Plot average	1928-29	1931-32
I	55	22	0	382	467	0
II	98	72	7	397	350	0
III	326	340	17	292	213	0
IV	935	807	39	567	382	0
V	207	133	2	240	160	0
VI	298	142	3	175	167	0
VII	357	110	6	190	96	0
VIII	1,138	483	13	1,006	912	1
IX	1,012	350	7	1,186	987	0
X	830	240	7	1,325	1049	0
XIII	175	48	2	267	127	0
XIV	272	113	3	195	151	0
XV	120	64	6	292	213	0
XVI	605	670	19	567	382	2

Partial sterility disease, which causes sterility on one or all branches of a plant, was investigated at Sabour and Pusa. It is fairly common in Bihar. Seeds did not transmit the disease. Juice from four sterile branches injected into 200 plants did not produce the disease. Certain pure lines are less susceptible than others. Three Sabour types and two Pusa types were practically free from the disease so that there is material to replace local susceptible types while the investigation of the cause is proceeding.

Gram. The study of the leaf-blight (*Mystrosporium*) was continued on 95 pure types of gram and five have remained free. So far the disease has been found only in Pusa, there being no trace of it in Sabour, Lyallpur and Coimbatore. It was found that steeping in 15 per cent. formalin kills all spores adhering to the outside of the seed and the fungus was not found inside the seed. Wilt caused by *Fusarium*, collar-rot caused by *Rhizoctonia* and *Sclerotium* were also investigated.

In the Punjab the practical result of the study of a gram blight, whose causative fungus *Mycosphaerella pinodes* is closely allied with that causing a similar blight in Southern Europe, was that the provision of uninfected seed from another district where the disease had not appeared was a sufficient control, but this has to be done on a large scale to prevent re-infection.

Wilt is the most important disease of gram in the Central Provinces but the *Fusaria* so far isolated from diseased plants have not reproduced the disease, hence it was suspected that a fungus may not be the real cause.

Wilt of groundnut, black gram and gingelly, caused by *Rhizoctonia bataticola*, was studied at Coimbatore. The erect varieties were more susceptible than the spreading ones. In 28 varieties the percentage of infection varied between 1 and 28, the variety Sugathur being the least susceptible. This disease was also found in the Central Provinces where it was observed that the variety Akola 10 was little affected.

Betel. The collar-rot of *Piper betel* has been studied in Pusa, Dacca, Nagpur, Poona and Mandalay. At the first three places the disease is believed to be caused by *Phytophthora parasitica*. In Bengal, Bombay, Burma, and Central Provinces, Bordeaux mixture has been found to be a preventive but, in the first locality, only when there is not too much flooding. The disease has also been located in Central India. In the cold weather in Bengal another fungus *Rhizoctonia solani* does much damage but can be controlled by a weak solution of kerol applied to the soil. *Sclerotium refsii* also does some damage and there is indication that it too can be controlled in the same way. Above all things, careful

sanitation is necessary to destroy all infected materials. A mildew of *Piper betel* in Burma was controlled by sulphur dusting.

Coffee. In Mysore, the spraying of coffee estates for the control of the three important diseases, black-rot, leaf-disease and die-back, has shown a very marked increase. It is estimated that about 6,000 acres were sprayed during the year 1931 against an estimated 3,000 acres for the previous year. Even with the reduced price of coffee that is now prevailing this has, on estimates received from the planters concerned, given a net increase in value of crop amounting to at least Rs. 3 lakhs. The operations against *areca kolcroga* and coffee diseases together must have given a net return to the growers in the neighbourhood of Rs. 10 lakhs or nearly twice the total budget allotment for the Mysore Agricultural Department proper. The rapid increase in spraying more especially on coffee estates has made it imperative that thorough investigations be made on the efficacy of different types of spraying apparatus, of different spray mixtures and of adhesives. The results so far indicate that resin-soda, first introduced by the department in 1909, is a much more effective adhesive than lime caseinate which is now generally used. A particularly promising new adhesive in the form of linseed oil has been tried on a large scale. This appears likely to replace the lime caseinate adhesive and seems certain to increase greatly the effectiveness of the spray. It may be possible through the use of a more efficient adhesive to decrease materially the strength of the spray used and so to decrease its cost. This is a matter of very great importance at the present when the low prices ruling necessitate the most economical use of money possible in connection with all agricultural operations. The Scientific Officer of the United Planters' Association who is attached to the Coffee Station, has investigated the seasonal variation of coffee leaf-disease. His results have recently been published giving definite information as to the seasons and conditions under which leaf-disease spreads and most valuable information as to the time when spraying must be done to give satisfactory results. It was definitely established that at a certain stage in the life-history of the fungus it permeates the leaf tissue.

Arecanut. For spraying arecanut bushes in Mysore, materials were supplied to spray 4,900 acres or about two-and-a-half million palms, and a new type of nozzle was introduced which added to the efficiency of spray while not seriously affecting the spread of the operation, a most important factor owing to the limited time available for spraying during the monsoon.

Tung tree. In Bangalore, an interesting *Phytophthora* probably a strain of *P. palmivora* Butl. was isolated from *Aleurites fordii* (the Tung oil tree) seedlings growing in the laboratory compound at Bangalore. The seeds were got from Kew and the seedlings were about four months old at the time the infection was noticed. Infected leaves show leaf-spots, at first limited by the prominent veins, and later spreading to the whole leaf. Affected leaves finally drop down. Inoculation with the zoospore suspension on the under surface of healthy leaves was successful and the fungus was re-isolated.

Bordeaux mixture was also used effectively against a bark-rot of citrus in the Central Provinces, and in the Punjab citrus canker, a disease caused by a bacterium, was said to have been effectively controlled by spraying with Bordeaux mixture (4 : 4: 50). Sulphur dusting was used with good effect in Bombay for rust of *jowar*, powdery mildew of grapes and of peas, rust of figs and red leaf blight of cotton ; and in Madras, Bombay and Burma for grain smut.

10. Entomology.

Locusts. The study of the locust problem in this country was placed on a stable footing by the acceptance of the recommendations of the Board of Agriculture, which met at Pusa during December, 1929. The Locust Bureau was instituted by the Imperial Council of Agricultural Research and locust intelligence was received, compiled and distributed regularly from the beginning of March, 1930. Since December, 1930, a scheme of locust research, financed by the Imperial Council of Agricultural Research, has been in operation. Studies on the different aspects of the locust problem are in hand. A scheme of survey has also been initiated to discover the permanent breeding grounds of this pest, and survey

parties have already visited various parts of Baluchistan and the Sind Valley, and have discovered solitary locusts in various parts from Jacobabad to Karachi, in the interior of Baluchistan and along the Mekran Coast. During 1932 breeding under natural conditions was going on at Pasni, where a field laboratory has been established to study locusts in their natural surroundings.

A brief history of the recent locusts outbreak that started in 1926 and culminated in 1930 may not be out of place. There is definite information of adult locusts being found in Las Bela State in August and in Karachi and Tharparkar Districts of Sind in September, 1926. These fliers must have originated from the eggs laid during the spring from February to May. This suggests the extensive presence of over-wintered fliers during 1925-26. Hoppers were actually noticed in the river Hub (Karachi) in November. These had developed from the eggs laid in July, August and September. Thus breeding was undoubtedly going on in parts of Baluchistan and Sind in 1926. From September onward the fliers of the second brood started appearing and spread over Sind. By December 1926, the fliers had reached Punjab, and by February 1927, they had spread over the greater part of the province except the south-east. Simultaneously locusts were spreading over Rajputana. By March they had further spread over south-east Punjab and the United Provinces. A flight had reached Pusa in Bihar by the beginning of July 1927. During 1927 eggs were laid over a greater part of this area in March and April and again in July and August. From 1928 to 1930 the intensity of infestation increased and was at its highest during 1929 and 1930 when both the broods of locusts developed over the extensive tract comprising Baluchistan, Sind, Rajputana, the Punjab and the United Provinces. They did enormous damage.

During February and March, 1930, locusts were present and laying eggs in the eastern and southern parts of the Punjab and in the western part of the United Provinces. They were also breeding in Baluchistan and Sind. By the end of May the newly hatched fliers had spread over the greater part of the Punjab and United Provinces and gone as far east as Gorakhpur and as far south as

Rewa. During June they reached as far east as Patna and Ranchi and were present in Bhopal. During the next two months, *i.e.*, the monsoon season, they disappeared from the eastern portion of the United Provinces and were restricted to the Punjab and the most western parts of the United Provinces. After the monsoon season they once more extended their area of distribution and went as far as Akola in the Central Provinces, and also reached Warangal in Hyderabad and Rangpur in Bengal. During October and November they were present in the Punjab, Rajputana, the Western Indian States and Central Indian States, and were reported from Bombay and Ranchi. In December they were reported from Lakhimpur in the extreme north-east of Assam. During 1930 they reached the extreme limits of their distribution in India, but died out in these inhospitable regions.

In 1931 the attack was very mild. Up till June the locusts were confined to Baluchistan and Southern Sind, and occasional reports were received from the Punjab and Ajmer. During July, however, the swarm visited south-eastern Punjab and north-western United Provinces, and extended towards the west to Baluchistan. Frequent reports were received from Rajputana. This continued till the end of August. From September onward the area of locust distribution decreased and during October to December locusts were only reported from western Rajputana, Sind, eastern Baluchistan and along the Mekran coast.

During 1932 the swarms were only reported from a few places in Baluchistan. The field laboratory at Pasni reported a swarm in June, coming from the north-east. Reports were also received of thin swarms from some of the Western Indian States. Since June no swarms have been reported.

From this brief survey it appears that the locusts originated in Sind and Baluchistan and successive waves of invasion having reached the Punjab, United Provinces, Rajputana and other parts of India, died out ; and locusts were finally restricted to the Sind-Baluchistan area again, which perhaps with certain parts of Rajputana, forms a permanent breeding ground of *Schistocerca gregaria* in India.

Other Insect pests—Sugarcane. From an account of a large series of egg-masses at various periods of oviposition, it was seen at PUSA that only a very small percentage of borers entered the newly planted canes. By the end of June *Emmalocera depressella* and *Diatraea* spp., especially *Diatraea venosata, Wlk.*, were the predominant borers. The bionomics of these and an intensive study of their egg-parasites were under investigation. A series of examinations with a view to ascertaining the incidence of attack of borers and termites were made. One thousand canes each of Co. 213 and Co. 205 which had been planted in February were examined in December 1930 with the following result :—

—	Undamaged	*Scirpophaga nivella*	Stem Borers	Root Borer	Termites
Co. 213 . . .	7·1	73·2	23·5	27·7	66·9
Co. 205 . . .	14·1	80·3	8·3	39·0	33·0

Again the following varieties Co. 205, 210, 213, 214, 223, 281, 285, 287, 290, 295, 297, 298, 299, 301, 302, 303 and 305 planted in February 1930, were examined for borers and termites before their despatch to the crushing mill. Of these the top-shoot borer, *Scirpophaga nivella*, was found to be bad in the following, *viz.* :—

	Per cent.
Co. 205	83·3
Co. 210	85·0
Co. 214	83·4
Co. 301	95·0
Co. 303	81·6
Co. 223	50·0

As regards the stem-borers (*Diatraea venosata, Argyria sticticraspis* and *Chilo zonellus*), Co. 213 suffered the most (15·5 per cent.) and Co. 231 the least. Termites had attacked Co. 214 the most (16·8 per cent.) and Co. 299 the least (7·7 per cent.). It was found that the eggs of the top-shoot borer were actively parasitized during March and April. The effect of the continuous collection of the egg-masses has given tangible results and is within the capacity of the

cane-growers in all areas. The root-borer (*Emmalocera depressella*) was very active from the beginning of May to the middle of June, being the principal borer at this time when the other borers are rendered rather quiescent by the high temperatures prevalent. By the third week in June, it was found to be parasitized by a Braconid. A study was made of the alternative hosts of cane-borers especially wild grasses. In MYSORE one of the most promising items of work was the mass-rearing of an important egg parasite of various serious moth borers. Liberation will have to be carried out on an extensive scale before the effect of this method of borer control can be judged and this will be undertaken at once.

In the PUNJAB, the study of the relative extent of damage done by sugarcane borer to different varieties of sugarcane was continued and one highly susceptible variety showed damage as high as 90 per cent. In the vicinity of Gurdaspur sugarcane fields were attacked to the extent of 25 to 30 per cent. By way of control, the removal of the damaged central shoot and treatment of the cavity thus created with petrol spirit or derrisol resulted in a mortality to the pest varying from 90 to 30 per cent. It was found that individuals of the sugarcane *Pyrilla* lived for about a hundred days between November and March : thus it appears that they can live through the Punjab winter as adult insects. It was also found that this pest had a variety of food plants including wheat, oats, guinea grass, several wild grasses and this adds to the difficulty of its control.

Rice. In Ganjam and Malabar rice grass-hoppers (*Hieroglyphus banian* and *H. orizivorous*) do serious damage. Badly attacked fields look as if they had been grazed down to stalks a foot high. Ploughing where possible from January to March and scraping the bunds to a depth of 3 or 4 inches dislodged and brought to the surface the egg-masses which were destroyed. The effect was good but the operations have to be carried out over a large area to be effective. A study of the mealy bug of rice in Tanjore was taken up and work was done on the blue beetle of rice and also a small bug, *Nilaparvata lugens*, in Malabar. As the last named bug had the habit of jumping down from the plants into the water

below on the least disturbance, advantage was taken of it by kerosenating the surface of the irrigation water and then dislodging the bugs, whereby most of them were caught in the oil film and destroyed.

In the PUNJAB, investigations on the life-history and seasonal cycle of the rice stem borer were continued. A study of the comparative damage done to the early and late-sown rice showed that in the early-sown crop the percentage of attack varied from 1 to 19 per cent., whilst in the late crop it averaged from 38 to 87 per cent. In the early crop the number of borers hibernating in the stubbles was found to be 37 per thousand stubbles, whilst 352 were found in the case of the late crop. Rice plants growing under shade were found to be much more damaged than those growing in the open. Similarly infestation of the crop growing on low-lying places was higher than that on level fields. The work done up to the present seems to show that burning of the stubbles *in situ* is not a sufficient method of controlling this pest. Many of the caterpillars seem to hibernate below ground level. The only effective remedy so far appears to be ploughing up the land, collecting the whole stubbles and burning them. In BURMA, the rice hispa which did widespread damage in Pegu and surrounding districts and *Erotylid* grubs from Bhamo districts were studied.

Cotton. In MADRAS counts were made to find out the comparative intensity of stem-weevil attack on areas where the Pest Act was enforced in the Pollachi tract during the year. Generally, the weevil infestation has been found to be comparatively less in villages where the Pest Act was enforced. Counts taken in December and January 1930 showed the existence of 67 per cent. attack on Cambodia cotton and 24 per cent. in the country cottons. The percentage of deaths was however low. In April the percentage had risen to 96 in Cambodia, while in the indigenous cottons it rose to 59 per cent. This year the incidence of attack seemed to be very high.

In the PUNJAB, the scheme for the investigation of pink bollworm financed by the Indian Central Cotton Committee originally for a period of five years, was further extended for another two

years. The relationship between climatic factors such as temperature and humidity and the intensity of attack of this pest and its distribution over the province, the influence of temperature on oviposition and egg-hatching, the sources of infection and phototropism are being studied. Observations on the bionomics and alternative food-plants of spotted bollworm were continued. It was observed that the flower buds and fruits of the alternative food-plants of spotted bollworms, such as *bhindi* and hollyhock, attracted a large number of these insects throughout the fruiting season. The preliminary work carried out by the Indian Central Cotton Committee's research scholar at Khanewal and Lyallpur on a study of the white-fly of cotton showed that although it is improbable that this fly is the main cause of the cotton failures which have occurred in the past, it is nevertheless a serious pest of the cotton crop. The Indian Central Cotton Committee, therefore, have financed a research scheme to work out the life-history and control measures for this pest. The preliminary work established the fact that 12 generations of this pest were produced in a year. The average duration of the life-cycle of this insect from April to September was 17·5 days, while between November and February it was prolonged to a maximum of 97 days. The migration of the pest from Deshi to American cotton and *vice versa* was investigated as also the nature of the damage caused to the cotton plant by it. As far as research into control measures has proceeded at present, the spraying of the cotton crop with rosin compound, once in July, August and September, gave the best results, but is as yet inconclusive.

The chief work of the Entomological Section in the UNITED PROVINCES was the investigation of the damage caused by the pink bollworms and of methods for preventing it. Experiments and observations have shown that the only serious source through which the cotton crop of the United Provinces becomes re-infected by the pink bollworm is the seed. The caterpillar remains dormant in the seed between harvest time and sowing. The sown seed thus contains the living worms which later turn into adult moths which lay their eggs on the growing cotton plant. Any unsown seed which

is kept until the monsoon also produces moths that fly to the cotton fields and spread the infection. Thereafter multiplication is very rapid, so that by the time the plants are nearing maturity there may be hundreds of thousands of the worms in an acre of the crop sufficient to cause injury to nearly every boll. Pink bollworms are killed almost immediately at 140°F., a temperature which does not in any way injure the germinating capacity of the seed. They are killed also at temperatures as low as 125°F. after prolonged heating. During the later part of March and months of May and June the heat of the sun is sufficient to raise the seed to the lower lethal temperature. In field experiments sun-heat is utilized for pink bollworm control but the larger stocks of cotton seed from the ginneries still remain a very important source of re-infection. For these mechanical heat-treatment in the ginneries is required. General co-operation of cultivators within the controlled area is necessary for an effective control of pink bollworm by using sun-heat. It is further necessary to insure the co-operation of all holders of stocks of cotton-seed for cattle-food or other purposes. Provision of sufficient treated seed for cattle-food as well as for sowing throughout the controlled area is essential for effectively combating the pink boll pest. Field control of pink bollworm was carried out in two areas : one in the Tarai jungles of Najibabad tahsil of Bijnor district and the other in the whole of Atrauli tahsil and a portion of Koil tahsil in the Aligarh district. The additional yield per acre in the controlled area was two maunds in Najibabad and about three maunds of *kapas* in Aligarh. The whiteness and freedom from infection obtained a premium of about Re. 1 per maund above the price of *kapas* from untreated areas.

Fruits. In MADRAS work was done on the mango hopper, fruit moth of orange, the grape vine beetle, and the wooly aphis of the apple. In the PUNJAB, investigations on the citrus white flies brought to light 7 species. Observations on the bionomics of the San José Scale were made in Kulu and extensive spraying operations were conducted and proved a valuable means of control. During this investigation it was discovered that wooly aphis did much damage but it too can be controlled by spraying. In the Kumaon

Hills wooly aphis is the most serious pest of fruit trees and its life-history was thoroughly studied. Brushing or spraying with kerosene, caustic soda and lime sulphur kills the aphis but it is most difficult to get all the cracks in the bark treated. Wooly aphis was not seen on Northern Spy and London Pippin.

Coffee. Information came to notice at the close of 1929 that the coffee berry borer, *Stephanoderes hampei*, had been found on coffee from Indian coffee estates. Immediate steps were taken by the Director of Agriculture, Mysore, to verify this information and to ascertain the spread of the pest. An attempt was also made to enlist the co-operation of all Governments and organisations interested in coffee cultivation, as it was felt that independent efforts by different Governments could not lead to successful control. A bulletin was prepared by the Entomologist for general circulation throughout South India giving the main facts known with regard to this serious pest of coffee and the work of organising investigation and control measures was being taken up actively.

A notification was promulgated in April 1931 prohibiting the importation of foreign coffee into India unless it be roasted or ground with a view to preventing the entry of this coffee berry borer.

Another important and promising line of work has been the investigation of various fish poisons with reference to their insecticidal value. There are a large number of plants growing in the Mysore jungles which furnish fish poisons and it has been demonstrated already that some of these are effective as larvicides for mosquitos and for use as sprays against plant lice. It also appears probable that they can be used for the making of sheep dips and to kill insect ectoparasites of other domesticated animals. An attempt is being made to isolate the active principle or principles of these fish poisons. Work of a somewhat similar nature is being done with seed which yields hydrocyanic acid in fairly large quantities. Attempts are being made to use this to control insects attacking stored grain and other stored products and also as soil disinfectant.

11. Useful insects.

Lac. On the recommendation of the Indian Lac Association and the Government of Bihar and Orissa, the Government of India decided in 1930 to dissolve the Indian Association for Lac Research and to transfer the future control of lac research to a Statutory Committee with powers to receive and expend the proceeds of the lac cess. A Bill to this effect was passed by the Legislative Assembly in July 1930. The Annual Report of the Indian Lac Association for Research shows that at the Lac Research Institute, Namkum, Ranchi, the well-conceived programme laid down during the time of the previous review has made satisfactory progress. Not only have the agricultural, entomological and chemical aspects been studied further but the investigation into the physical characters of shellac has made available knowledge useful to the consuming industry. A further development consists in a proposal to have this aspect of the subject studied more intensively in close proximity to the manufacturing areas.

On the plantation side, seven host plants were studied and experiments on suitable systems of crop-rotation, pruning of the host plants and manuring were continued. The result of liming the soil under *Acacia catechu* showed an increase in the lac crop. A comparison of the yields of scraped lac from each of the permanent manurial plots showed that the highest yield was obtained from the one receiving a complete manure (ammonium and potassium sulphates and superphosphates). On the bio-chemical side, the comparative study of good and bad lac hosts was continued with a view to study the factors that influence the suitability or otherwise of a plant to serve as a host as well as the actual food requirements of the lac insect and the depletion of these substances in the host plant. Experiments with cross infections so far indicate a marked improvement in the qualities of resin-producing efficiency, mortality and sex ratio. Work on the nutrition of the lac insect was continued by making chemical analysis of lac-bearing and non-lac-bearing shoots of various host plants, inorganic analysis of lac encrustation and insect bodies and periodical analysis of the soil

in a lac-growing area. It is hoped in this way to obtain information concerning the actual food requirements of the lac insect and the depletion of these substances in the host plant. Results from work of this type should eventually yield data showing how frequently any particular host can be cropped without deterioration and also what it is necessary to return to the plant in order to obtain the maximum number of crops from it.

On the technical side, an examination of the physical and chemical properties of certain stick lacs was undertaken and this should give valuable information as to the influence of the properties of stick lac on the properties of the manufactured product and, therefore, on the grading of stick lacs for different types of shellac. Another line of investigation that was taken up was to find out the effect of heat treatment on lac. This is a problem on which very little information is available and it is important, as the comparatively low softening point of shellac militates against its use for electrical insulation purposes. Hence an attempt is being made to evolve a shellac which, while possessing the essential properties of ordinary shellac, has a much higher softening point. The results of the investigation of the action of water and various chemicals on shellac films prepared from various mixed solvents has been published. The general conclusion arrived at from an examination of the work in the factory was that with suitable supervision as regards cleanliness, etc., at least 70 per cent. of the shellac manufactured in India could be fines and superfines provided the stick lac was not more than a year old when it got to the factory. The actual cost of manufacturing such superfine lac would not be more than the cost of manufacturing T. N.'s, for the fluidity of good quality, young, stick lac, shortens the time of melting very considerably with appreciable saving in expense, and crushing and washing losses are low. Unfortunately, however, so long as the price of shellac is fluctuating, the practice of storing stick lac for long periods will be resorted to and the ideal conditions whereby stick lac is cut, manufactured into shellac and exported to a cooler climate with as little delay as possible will not be realised. It is a point worthy of strong emphasis that stick lac, washed lac and shellac,

while stored in a hot climate are very rapidly polymerising and deteriorating in quality and in three or four years are almost ruined for many industrial uses. This rate of polymerisation is accelerated by increasing temperature. In cool climates it is relatively slow and in cold storage it is practically zero. It is obvious that, if the initial high fluidity of the lac is to be retained in the shellac, the time the material is kept in India, either as stick lac or shellac, should be reduced to a minimum and such storage as is necessary should be done in as cool a place as possible. It may be pointed out that this property of high fluidity is of the utmost importance to the moulding and gramophone industries which take over 50 per cent. of the exported shellac.

Investigation on the entomological side falls into two main groups, firstly the bionomics of the lac insect and secondly the insect enemies and friends of the lac insect and its host plants. A great deal of useful information has been acquired and made available, one item of which is an improved and simpler method of forecasting emergence. The average annual damage by insects to the lac crop is said to be in the neighbourhood of 60 per cent. so that the investigation of insect enemies of lac is an extremely important problem. It is essential that their life-histories and relationship with the lac insect be thoroughly understood and such work has been an important line of investigation. Fortunately several predators and parasites of these harmful insects are also under study with a view to their exploitation in a good cause.

12. Sericulture.

The sericultural industry in India is undergoing a period of stress owing to competition from China, Japan, France and Italy in the real silk market and also severe competition from artificial silk, and the general policy of the departments in those provinces and States --Bengal, Madras, Mysore and Kashmir—is to show the rearer how to lower the cost of production sufficiently to be able to meet competition.

In BENGAL there were twelve nurseries in 1929 and one less in 1930, mainly engaged in the production of pebrine-free seed which is

partly sold direct to rearers for commercial cocoon production and partly to selected rearers (mostly passed students of the sericultural schools) who carry out one multiplication under departmental supervision before selling the produce to the ordinary rearers. The produce of government nurseries was 16 tons in 1929 and 22 tons in 1930, while that of selected rearers was 22 tons in 1929 and 21 tons in 1930. The total production now represents about half the total sericultural seed requirements in Bengal. The Department is now in a position to make recommendation regarding the effect of manuring on increasing the production of leaf and cocoons. Artificial farmyard manure was manufactured on a practical scale at all nurseries and there was universal testimony to the value of this method of utilizing all refuse organic matter at so low a cost. Stabilised bleaching powder was successfully used as a disinfectant instead of formalin. Now a rearer can thoroughly disinfect his rearing shed and apparatus at a cost of one or two annas. Pure strains of the race Chotopoulu have been obtained which seem to do well in the environment where their ancestors existed but not elsewhere. On this account each nursery is trying to rear its own special strain.

Eri which feeds on castor appeared to have prospects in Howra, Bogra and the Chittagong Hill tracts where rearers prefer it because the food plant is less liable to be eaten by cattle.

A scheme for modernizing the reeling, doubling and twisting machinery of the Berhampore Silk Weaving Institute was drawn up with a view to making the Institute a nucleus for such improvement of Bengal silk as will enable it to compete on equal terms with imported yarn. During 1929-30, 1,682 cases of epidemic disease were reported of which 1,460 were successfully checked, representing a saving of about Rs. 44,000 to the rearers. The corresponding numbers in 1930-31 were 1,471, 1,289 and Rs. 58,000. The failures were entirely due either to negligence of the rearers or to delay in reporting the outbreak. The operations of the sericulturist demonstration staff in the villages continued and the Bengal Co-operative Silk Union continued to flourish.

On account of the low prices and unfavourable seasonal conditions the area under mulberry in the MYSORE STATE declined from 46,572 acres in 1928-29 to 43,634 acres in 1929-30 and then to 42,880 acres next year. To meet the situation, the Department intensified its propaganda and sericulturists were advised to lower the cost of production by restricting their rearings according to leaf-supply, by using quicker and higher yielding cross-bred strains and by timely attention to cultural operations. The government grainages supplied to silk farms and sericulturists 9,79,000 D. F. layings during 1929-30 and 12,17,650 during 1930-31 ; of these hybrids and pure races amounted to 3,24,015 in 1929-30 and 2,97,332 in 1930-31.

The preparation of cross-bred layings was handicapped for want of a sufficient supply of pure foreign races but arrangements have now been made to obtain fresh stocks every year. In addition to government grainages there were 5 aided grainages in 1928-29, 11 next year and 13 in 1930-31. These grainages in their turn supplied 298,648, 689,207 and 1,241,456 of layings in the respective years. The 460 selected rearers in 1929-30 and 496 in 1930-31 put on the market 140 lakhs and 350 lakhs respectively of prepared cocoons.

Experimental work was continued at the Central Farm at Mysore and Chennapatna on the rearing of foreign races and hybridization. The eggs of new races obtained from Japan gave uniformly good results by themselves as also in combination with the Mysore race. Experiments with the hybrids were continued and work was started to improve the Mysore race by selection. Rearing experiments with mulberry leaves plucked early in the morning and late in the afternoon showed that the afternoon leaves were more nutritious than the morning leaves. Experiments in mulberry cultivation consisted of grafting of several foreign varieties on Mysore mulberry, manurial experiments, improvement of the cultural operations, isolation and multiplication of local male mulberry and spraying experiments with a solution of potassium sulphide to eradicate mildew in mulberry. The Japanese varieties of mulberry have been propagated by morcottage, layering and budding as it was found difficult to propagate them by cuttings.

Experiments were started to study the quality of silk produced by the cocoons of several combinations with foreign races. Facilities were given for training in the several farms of the Department, the trained men being encouraged to start aided grainages.

Owing to the continued depression in the silk trade, the Department had to increase the amount of sericultural loans during the year 1930-31, the total sum advanced being Rs. 12,715. The Mysore Silk Association took an active interest in the advancement of sericulture in the State ; it organised a co-operative society for the joint sale of silk produced at the domestic basins and issued a fortnightly bulletin giving market prices of silk, cocoon, etc.

In MADRAS work was confined to cultural experiments of mulberry, hybridization and distribution of disease-free seed. A number of successful crops of French univoltine and Mysore races were raised at Conoor. The Hosur Silk Farm, started in 1929, raised successfully in 1929-30, 31,120 seed cocoons and in 1930-31, 2,90,343 cocoons from which disease-free layings were prepared and sold to rearers.

The peripatetic rearing party stationed in Kollegal district, continued to render assistance to the rearers by moth-testing at their houses, giving instructions in the use of microscopes, assisting literate rearers in the starting and maintaining of grainages and in the installation of improved types of reeling machinery. 2,34,999 layings in 1929-30 and 1,89,843 in 1930-31 were tested by the party.

In BURMA the sericultural operations are centred round the nurseries at Maymyo, Mandalay and Paukkaung in the Prome district. The main work of Maymyo nursery is to receive superior foreign races of univoltine silk worms for crossing with indigenous multivoltine races. The hybrids produced at this station are reported to have largely replaced the local multivoltine kind. Experiments on the pruning and manuring of mulberry were also carried on. As a result of the observations made by the Entomologist during his study leave in Japan, the practice of the grafting of mulberry has been introduced. During 1930-31 ten races were imported from Japan and were maintained in addition to the several crosses produced at the station. Two-thousand-six-hundred-and-

sixty seed cocoons and 120 layings in 1929-30 and 5,355 seed cocoons and 608 layings in 1930-31 were supplied from this station. The nursery at Mandalay is maintained to transfer the worms from Maymyo to a warmer climate in the cold weather. The Paukkaung nursery was opened with the idea of resuscitating the silk industry which once flourished in that locality, but several of the attempts made by the Department to give a training in sericulture to the local people have so far proved a failure. The Mission nursery at Leiktho continued to function with the assistance of the Department.

ASSAM. The Sericultural Section of the Industries Department maintained two sericultural stations, one at Titabar and the other at Shillong. Three species of silk worms were reared at the Titabar Station, *viz.*, *Eri.*, *Pat* and *Muga*, and the yield records showed that in regard especially to the univoltine French brood, the Shillong stock gave much better yield in the number of cocoons and the silk content than the Titabar stock. The Shillong Station appears to be particularly suited for rearing purposes; a univoltine variety which gave a yield of 14·5 grms. per 100 cocoons at the Titabar Station, gave at Shillong an yield of 38 grms. per 100 cocoons. As a result of the successful propaganda work conducted by the departmental staff, silk-rearing is reported to be extending in the province.

CHAPTER IV

AGRICULTURAL ENGINEERING.

1. Hydraulics.

In the UNITED PROVINCES where strainer tube-well construction has been in progress for several years and where 248 large tube-wells suitable for power pumping plant and about 200 smaller ones have been installed for private individuals, the Engineering Section has been completely reorganised and is now in a better position to undertake its work promptly and effectively. In 1928-29, the number of tube-wells constructed was 71, comprising 27 tube-wells of 6 inches and over and 44 smaller ones. In 1929-30 the total number was 39, consisting of 17 tube-wells of 5 inches and over and 22 strainer wells of $3\frac{3}{8}$ inches. In 1930-31, 129 projects were completed consisting of 34 tube-wells of 5 inches and over, and 95 of $3\frac{3}{8}$ inches, while 146 projects comprising 70 tube-wells of 5 inches and over and 76 strainer wells of $3\frac{3}{8}$ inches were in progress. The smaller outturn of work in 1929-30 was attributable to a large extent to the lack of *takavi* allotments due to the very large amounts of *takavi* loans given out for seed and bullocks. In 1930-31, a substantial improvement was shown in the volume of work undertaken. The most successful tube-well in 1929-30 was a 10-inch diameter work with a discharge of 533 gallons per minute and a characteristic of 62·74 gallons per minute per foot depression, and, again, in 1930-31 a 10-inch well with a discharge of 894 gallons per minute and a depression of 18 feet 5 inches. On calculating the running costs of tube-well installations, it has been found that the bigger wells are cheaper than the small ones, the cost of water being 0·68 annas per thousand gallons in the last-mentioned well. The following important projects were on a more ambitious nature than those hitherto undertaken, *viz.*, a tube-well in Moradabad to irrigate $4\frac{1}{2}$ square miles, a pumping scheme on the Bhakra river to control 1500 acres, another on the Ken river for 1000 acres, a third on the Pathri river to command 950 acres and a fourth on the

Rapti river for 650 acres. There is immense scope for private irrigation schemes of this kind from rivers, though with the exception of a few in Gorakhpur district there are practically none in the province. Tenders have been accepted for the electrification of tube-wells in the electric grid area and it is anticipated that the successful completion of these installations will make electrification of tube-wells more popular.

With the introduction of the "Brownlie" slip strainers, and latterly the "composition" slip strainer, the yields of many wells in the PUNJAB have been increased from one hundred to three hundred per cent. This success has created a rapidly growing demand for small power plants and active propaganda has been engaged in, to encourage this system of water lifting. At the same time the paramount importance of installing plants which cannot withdraw more water than the well will safely yield, has been impressed on land-owners. After many years' experience of sub-soil water-flow in the Punjab alluvial deposits, the Agricultural Engineer feels that he is in a position to determine with exactitude the discharge of water which can be taken from ordinary wells augmented by strainer tubes. Three deep trial bores were made, in one of which a plentiful supply of water was tapped at a depth of 404 feet but in the other two taken down to 332 feet and 509 feet, respectively, no suitable water-bearing stratum was found. The demand for the installations of small pumping plants in the Ferozepore Sub-Division has steadily increased and several bores preliminary to such installation were made. Yields of water varying from 3,000 to 15,000 gallons an hour were obtained from wells bored for this purpose under heads in no case exceeding the critical limits of the sub-soil. It is expected that this type of work will increase to a great extent, when cheap electric power from the Mandi Hydro-Electric Scheme becomes available. In BIHAR AND ORISSA, 24 tube-wells were installed in 1929-30 and 25 next year, of which 6 were 5 inches and over. There was some demand for power pumping installations on river banks and several portable pumping sets were supplied for the purpose. In BOMBAY, several power pumping plants were installed for cultivators and also at Government farms

and schools, wherever there was a possibility of demonstrating a power pumping unit.

2. Well-boring.

In most provinces the agricultural departments continued to maintain a staff for the improvement of village wells by boring and for trial bores in connection with the construction of new masonry wells for irrigation and general agricultural purposes.

In the UNITED PROVINCES, the number of borings made in existing and in proposed wells was 1,543 in 1929-30 with 1,137 successes and in 1930-31, 1,442 with 1,070 successes. The total number of wells bored by the department up to date is 27,243.

The average cost per acre, assuming that ten acres are irrigated per well, was Rs. 34 in 1929-30 and Rs. 36 in 1930-31, and running costs ranged from annas 6 to Rs. 3-8 per acre of water. These figures bring out the fact that, except where the lift is small, such installations are only profitable in an intensive system of agriculture where valuable crops like sugarcane and tobacco are grown.

The system of carrying out tests on each well both before and after boring has been adopted in order that a definite measure of the improvement effected may be available. This system is already in practice in the PUNJAB where no boring is reported as successful unless the supply is increased by at least 20 per cent. In this province, 935 wells were bored in 1929-30 of which 786 were successful, while next year 887 were bored with 686 successes. In 1929-30, 475 of the wells were fitted with an average of 13·9 feet of strainer and in 1930-31, 449 wells had an average of 14·5 feet. This shows a tendency on the part of well owners to use greater length of strainer in the hope of obtaining a greater yield. In BIHAR AND ORISSA, the number of open small borings in 1929-30 was 323, of which 238 were successful and next year 222 of which 197 were successes. Forty small bores had to be abandoned as rock was met close to the surface. Proposals have been made for a small rock-drilling plant to investigate possibilities in the Chota Nagpur Division and adjoining areas. In BOMBAY, 78 borings were made of which 17 were unsuccessful. A good many were required for drinking water

rather than for irrigation, and boring was carried out under very difficult conditions, most of the unsuccessful ones being due to boulders. Boring operations in Bombay were closed down in November 1930 owing to financial stringency. An efficient soil-sampling outfit portable on a camel and having a collapsible folding derrick was designed for soil-sampling in SIND, where samples down to thirty feet were required in large numbers.

3. Lift Irrigation and Water-lifts.

The installation of the larger size tube-wells already referred to involved the provision of suitable power pumping plants. In the PUNJAB, lift irrigation formed a special division of the Agricultural Engineer's Section under the charge of an Executive Engineer. The Division deals primarily with the investigation of the possibility of irrigating areas not commanded by canal water either by means of tube-wells or pumping water from rivers. The work embraces the preliminary survey of the area, preparation of plants and estimates for the projects. During the four years of its existence, this Division collected some very valuable data regarding the flow of water through fine gravel and certain extensive schemes for the irrigation of large tracts of land in various districts of the province. Owing to financial stringency it was abolished in 1930. The possibility of driving a Persian wheel by electric power was investigated but so far the cost of reduction-gears was so high that attention was turned to the evolution of a centrifugal tubular pump for small discharges, and a pump has been designed and made up which will be tested and modified as found necessary in the coming year.

In MADRAS the Industrial Engineer erected 49 and 46 pumping plants in the two years 1929-30 and 1930-31 as against 51 in 1928-29, bringing 605 and 785 acres under irrigation. 304 and 298 power pumping plants were inspected and overhauled by his staff under the Industrial Department's maintenance scheme, under which the owner pays Rs. 10 per annum for three inspections. In BIHAR AND ORISSA two power pumping plants were erected in 1929-30, one delivering 20,000 gallons per hour and the other 38,000 gallons. Next year, two similar plants were

installed. The success of the demonstration with the portable pumping sets is creating a demand for this class of water-lift. In the CENTRAL PROVINCES a crude-oil engine driving a 3-inch centrifugal pump was installed to lift water 55 feet to irrigate 12 acres for sugarcane, oranges, plantains and vegetables.

4. Improved Water-lifts for Bullock-power.

The Persian wheel made of metal received attention in the Punjab, Bihar and Orissa, the Central Provinces and Bengal. As a result of testing 69 various patterns in the competition mentioned in the last Review, a metal wheel of a high standard of efficiency and a reasonable price has been achieved.

In BIHAR AND ORISSA 25 Persian wheel pumps were sold by the department. Here, too, improvements have been made in the design and a number of local foundries have taken up the manufacture. Private manufacturers report that the demand for the Sabour type of water-lift has increased so considerably that the price has been reduced.

In the CENTRAL PROVINCES, Persian wheels are beginning to gain popularity and the department erected twelve of them. In BENGAL an improved bullock-driven pump for irrigation where the suction lift does not exceed 20 feet and another for lifts up to 50 feet as well as two types of Persian wheel for small and large bullocks have been designed. In MADRAS, improvements to the roll-easy mhote wheel by providing it with a steel sleeve race and roller-bearings and to the circular mhote, so popular in South Arcot, were under consideration.

5. Embankments and Channels.

Few things in Indian farming offer a better field for useful work by the departments of agriculture than permanent improvements to the land. This is especially the case in undulating country where a large percentage of the annual rainfall runs off the fields into the *nullahs* carrying with it much fertile soil. Both in the prevention and checking of erosion, in the carrying out of small irrigation projects and in economical distribution of water, a sur-

veying staff that can take levels and design simple works can render material asistance to the cultivators. In BOMBAY four Bunding Officers assist the public in this way. They prepare small projects with plants and estimates for individuals and groups of individuals and their services are in such demand that a large increase of staff could be very usefully employed. In 1929-30, in the Bijapur district, plans and estimates were prepared for 32 bunding schemes, costing Rs. 41,800, in 30 villages and for 14 reclamation schemes of small *nala* beds, costing Rs. 17,100. In Belgaum and Dharwar districts, 45 bunding schemes, dealing with 700 acres in seven villages, were prepared. A large joint scheme dealing with 313 acres at Tallur is under preparation. In the Deccan where there is only one bunding officer, 71 direct applications from the public and 34 through the Revenue Department were received. In Khandesh and Nasik, where this kind of service has only recently been organized, the bunding officer has dealt with 51 schemes. In 1930-31, projects were prepared for 35 schemes, located in 26 villages, estimated to cost Rs. 36,725. In the Belgaum and Dharwar districts, taken together, 22 projects, estimated to cost Rs. 16,700, were prepared; in the Khandesh and Nasik division, 36 projects and in the Deccan, 28 projects, while in the last named another 110 applications were on the books to be dealt with in the future. Similar work but on a smaller scale was undertaken in Bihar and Orissa, the United Provinces and the Punjab.

6. Agricultural Machinery.

Another activity that has occupied the attention of all agricultural departments is the development of cane-crushing machinery. With the spread of the new Coimbatore high-yielding canes in northern India, the limited capacity of the three-roller bullock mill is a serious handicap in those cane-growing areas where white sugar factories do not exist and this has caused the departments in the Punjab, United Provinces, Bihar and Orissa and Bengal to pay much attention to small power-driven sugarcane-crushing mills. Already several such mills are on the market and many of them are in use, but none is considered to be quite satisfactory. For experi-

ments in devising a satisfactory small power cane-crushing mill, the Imperial Council of Agricultural Research in 1930 made a grant of Rs. 8,000 to each of these four provinces. In the Deccan canal zone alone 81 mills of this kind were working during 1930-31 and that gives an indication of the demand that has sprung up. Progress has been made, too, in the design of many agricultural implements. In MADRAS, the Research Engineer was provided with a well-equipped workshop which should enable him to carry on his investigations unhampered by lack of space and equipment. As a result of his work the range of ploughs suitable for dry land conditions has been limited to two types, a light plough of the Meston type and a medium plough of the Monsoon Chattanooga or Punjab type. These are for ordinary conditions where the draught is limited to one pair of poor bullocks or one pair of reasonably good bullocks, respectively. With a view to aim at good quality of work and service, almost all ploughs in use at several of the agricultural stations are being fitted up with short beams and double-handles. Avery's Hindustan plough was subjected to a further trial in wet lands. The consensus of opinion was in its favour as the output of work is 30 per cent. more than that of the Meston plough, but its price being on the high side prevents cultivators from purchasing it in large numbers. An improved automatic seed-drill is under trial. Another item of work that has received considerable attention is the construction of an improved type of bullock yoke. A suitable design has been worked out, but like most other contrivances which are to be placed before the cultivator for his acceptance, it has to be made to a price before its greater mechanical efficiency will appeal. As its competitor is a log of wood, this is the more difficult part of the problem. Different types of hand-driven groundnut decorticators and chaff-cutters were tested. In BOMBAY a modified improved seed-drill was granted a patent by the Patent Office, Calcutta, in 1930 and was further improved. This drill is designed to sow any kind of seed to any depth up to six inches, for a seed-rate varying from 3 to 80 lbs. and for rows at varying distances apart. A new winnower, fitted with sieves to deal with *bajra*, *jowar*, rice and wheat, was put

through exhaustive trials with good results. Similar research was in progress on harrows, hoes, ploughs and a groundnut harvester, while a cotton-stalk extractor received special attention. A new material called Framotex Steel for the construction of implements was tested with promising results. A power chaff-cutter was demonstrated at five centres for preparing *jowar* for storing in silos. In BENGAL several models of improved iron ploughs suitable for ordinary cattle have also been produced by the Agricultural Engineer. Of these "Sobkam No. 2" seems certain to be widely used and the price, complete with hardwood frame, is only Rs. 5-8-0. This "Sobkam" is, therefore, much the cheapest iron plough on the market, and while it approaches the ordinary country plough in price, it can safely be said that it is not only two or three times as efficient, but that it will last at least twice as long. The "Sobkam" plough is now being used at all Government farms, but orders are also coming in from the public, a phenomenon hitherto without precedent in this province. Improved boiling-pans for *gur*-making were also under trial. In the PUNJAB work was carried out on the production of a suitable small winnower, baling press, and flame guns for the destruction of locusts. In BIHAR AND ORISSA the improved Bihar ploughs, cultivators and ridge ploughs have become popular; 1,384 were sold in 1929-30 and a somewhat smaller number next year. A modified Egyptian Norag, which is extensively used for threshing wheat in Egypt, was made and tried at Sabour with good results. In BURMA the Agricultural Engineer, who was appointed in April 1929, naturally spent some time in becoming familiar with the problems awaiting solution and has taken up the improvement of the seed-drill, winnower, an all-metal light water screw, detachable points for plough shares, and *gur* furnaces In the CENTRAL PROVINCES, too, an Agricultural Engineer was appointed and has already successfully improved the Akola hoe and modified a groundnut decorticator so as to reduce breakage in shelling. At the INSTITUTE OF PLANT INDUSTRY, INDORE a new ridger for the interculture of cotton and other crops was evolved and already 529 have been sold. In MYSORE a smaller type of Mysore plough and a Kolar Mission plough have been made of

Bhadravati iron with the steel parts obtained from abroad, as no steel of the desired quality is now manufactured in India. A new seed-drill for *ragi* to regulate the seed-rate was under trial.

7. Mechanical cultivation.

The Burma Shell Oil Storage and Distributing Company of India, Ltd., has materially assisted the development of mechanical cultivation in India by undertaking experiments in conjunction with provincial departments of agriculture. At first they carried on ploughing demonstrations in Bengal, Madras, Sind and in several States, but afterwards concentrated their activities, so far as tractor ploughing was concerned, to a few areas and to definite problems in order to obtain data of value. At Mirpurkhas in Sind they ploughed about 600 acres on contract. While this work was in progress, the Bombay Government had decided to open six experimental farms in the Barrage area in Sind, that were to receive water in March 1932, and gave the ploughing to this company on contract. Different types of tractors were used and various implements. In the Dharwar district they also investigated the problem of the eradication of deep-growing weeds by deep ploughing with motor-tractors as opposed to the cable system. Here too several types of tractors, both kerosene and Diesel, were tried and mould-board and disc ploughs were used. Altogether 487 acres were ploughed. Considerable interest was aroused and many enquiries for work as well as enquiries regarding tractors were received. Reports were received of increased crop yields from various landlords whose land had been ploughed. The real test of the success of the work will be shown in a year or two, when it can be seen whether the grass (*Cynodon dactylon*) is growing again or not. At Raichur, too, in HYDERABAD STATE 1,425 acres of black cotton soil in weed-infested areas were ploughed to a depth of 10 inches. Full cost statements were kept to secure all the basal information necessary to provide for an accurate analysis according to the various circumstances met with. The Company proposes to continue this line of investigation as it is only by experience that the most economical way of running large ploughing projects can be discovered.

All their results were discussed at meetings of the Imperial Council of Agricultural Research. A tractor class was held with the help of the Company to give training to cultivators and college students in the handling of tractors and ploughs. A similar class for training in handling tractors, oil-engines and agricultural machinery was held in the Central Provinces. In the Punjab, Burma, Bihar and Orissa and Pusa work on tractors proceeded in the way of testing, and acquiring data of costs. The Fowler's steam ploughing tackle (double engine set) continued to be in great demand in the northern part of the Central Provinces and 927 acres were ploughed in 1929-30, but next year the area dropped to 690 acres due to the pinch of falling prices. In Pusa, too, the steam tackle was worked as before.

8. Electricity in Farming Operations.

At Cawnpore in the UNITED PROVINCES, experiments were conducted as to the relative cost of pumping, threshing and fodder-cutting. With a rate of 2·5 annas per unit for the first 900 units consumed per month and thereafter half that rate, preliminary experiments showed that the cost of the latter two operations was considerably less than it was when a kerosene engine was used. Now that seven districts in the United Provinces are covered by a "grid", the problem of usefully utilizing electric power in farm operations has arisen.

CHAPTER V

LIVE-STOCK.

1. Prevention and Treatment of Disease.

General Review.

During the period under review the financial position deteriorated in India in sympathy with the rest of the world, with the result that the great expansion of provincial veterinary services which was recommended by the Royal Commission on Agriculture in India was impossible and in most provinces it was even found necessary to reduce the already strictly limited financial provision for such work. Reductions in staffs had accordingly to be made and the steady increase in the numbers of hospitals and dispensaries which is required for the gradual expansion of provincial veterinary departments could nowhere be undertaken. Similarly the strengthening of the research staff of the Imperial Institute of Veterinary Research, Muktesar, and at veterinary colleges, which is so urgently necessary, could not be carried out and in some instances the work in progress had to be closed down for want of funds.

Various measures were, however, taken to organize research work on a basis from which greater efficiency should result and expansion should be easier in the future.

For example, arrangements were completed for the separation of the work of the serum production station, located at Izatnagar where new buildings are now nearing completion, from the research work carried out at the Muktesar Research Institute itself and preliminary steps were taken to organize the staff of this Institute into sections each to deal with a definite class of work.

Moreover, with a view to organizing systematic field investigation of local disease conditions, in provinces and states, funds were granted by the Imperial Council of Agricultural Research for the employment of a specially trained veterinary investigation officer

in each major province and state affiliated to the Council. These workers should in time provide more precise information on the prevalence and control of a great variety of diseases the investigation of which has not hitherto been possible owing to lack of specially trained staff.

The number of cases treated during the period, in hospitals and dispensaries and on tour, showed a steady increase from 3,411,932 in 1928-29 to 3,841,266 in 1930-31, and there is evidence that this work is being more and more appreciated as it becomes better understood; while castration by the Burdizzo method is also increasing steadily throughout the country. This work is of great value as a measure of livestock improvement, but much more is still required to make the position satisfactory.

The recorded mortality due to rinderpest was high during 1929-30 but the incidence of contagious disease of all kinds showed an appreciable fall in 1930-31. Rinderpest was still the main cause of mortality but might have been less had not the control of this disease by inoculation been considerably handicapped in certain provinces, owing to their inability to purchase the quantities of serum required to deal effectively with the large numbers of outbreaks which occurred, as a result of a fresh wave of infection which passed over wide sections of the country during the year 1929-30. The endeavours which have been made during the past two years to cheapen the cost of serum production at the Izatnagar Station are however proving successful and should result in considerably reducing the price at which this product can be supplied in future.

Various methods of anti-rinderpest vaccination, which have been to a certain extent adopted in other countries, have been under investigation at the Muktesar Institute but the results so far obtained do not indicate that any one of these methods is likely to prove entirely satisfactory for dealing with the disease under the conditions which obtain in India. Observations at the Imperial Institute of Veterinary Research, Muktesar, and recently in the provinces, indicate however that a method of vaccination against this disease, with goat virus of reduced virulence, which has

been maintained at the Muktesar Institute since it was first fixed on goats by Dr. Edwards in 1926, may prove a cheap and satisfactory method of dealing with rinderpest in India, particularly among the highly immune cattle commonly met with in the plains. Very encouraging results have been obtained, both at Muktesar and in the provinces, from field inoculations carried out on plains cattle to test the practicability and safety of producing a lasting immunity in such cattle by vaccination with this virus and similar inoculations, with goat virus alone, on calves having a proportion of European blood and from immune dams, have been tested with satisfactory results. These preliminary tests, on plains cattle in different parts of India and on a certain number of calves of mixed European and Indian blood, indicate that this virus can be employed with safety for inoculation in such animals without the simultaneous administration of a protective dose of serum, and more extensive tests of this system of vaccination are now in progress.

Should this prove a satisfactory means of protection, generally applicable in the field, it would be of great economic value to India, both by reducing mortality and by doing away, to a large extent, with the necessity for the use of protective serum, the cost of which has in the past been a heavy drain on the severely limited funds available for such work in the provinces.

Under money grants made by the Imperial Council of Agricultural Research arrangements have been made for the employment of veterinary disease investigating officers for the major provinces and Indian States. This investigation staff, distributed over the whole of India and properly employed, should be of great value in assisting Directors of Veterinary Services to test new methods of disease control as they become available and to carry out the precise field investigation which is so urgently required regarding the many obscure causes of ill-health and degeneration of stock which occur in India.

Steps were also taken by the Imperial Council of Agricultural Research during the period under review to draft an all-India Act for the control of contagious disease, and provincial governments were approached with definite proposals for adopting measures to

improve the general standard of education and technical training at veterinary colleges throughout India. Such a raising of the standard of training of veterinary graduates has now become more than ever necessary in view of the fact that the duration of the curricula at veterinary colleges in other countries has recently been raised to a 5-year minimum course, it having been found that the very wide range of subjects which fully trained veterinary graduates now have to take, cannot be dealt with in less. Without courses of training of approximately equal duration it is obviously impossible to give the thorough training in pathology, bacteriology and scientific disease control which has now become a huge subject in itself and without a satisfactorily high standard of education it is impossible to take full advantage of such advances in scientific knowledge which are of practical importance to scientific animal husbandry.

The long duration and cost of such education and training must however entail a material raising of the standard of remuneration of provincial and other veterinary staffs, from the very low standard which now obtains, if a steady supply of such highly qualified officials is to be maintained. If better careers are not open to them than is at present the case, it cannot be expected that young men of a suitable standard of education will undertake such costly education and technical training, and if it is decided that increased numbers of fully trained men cannot be paid at a reasonable rate, steps should be taken to increase their capacity for carrying out work in the villages by providing a subordinate class of stock-men, specially selected and trained to perform inoculations, first-aid treatment, and minor operations in the field.

2. Disease control in the Provinces.

During the early part of the period under review there was a general recrudescence of rinderpest throughout the greater part of southern and central India. The incidence and mortality from this disease increased markedly during 1929-30 and though considerably reduced in 1930-31 the loss was still high. This heavy mortality was apparently to some extent attributable to the inability

previously mentioned of provinces to bear the expense of the large quantities of anti-rinderpest serum required to deal adequately with the wave of infection which passed over the country, particularly in 1929-30.

In the Punjab, North-West Frontier Province, Baluchistan and Burma mortality was mainly due to other diseases of which haemorrhagic septicaemia, black-quarter, anthrax and foot-and-mouth disease were the most important, haemorrhagic septicaemia being responsible for 46 per cent. of the total mortality in the Punjab in 1930-31. It was the main cause of mortality in that province, and the Director of Veterinary Services reports that this disease is increasing with the increase in water-logged areas produced by the extension of irrigation. The same remark applies to disease due to entozoal parasites and a proposal is now under consideration, by the Imperial Council of Agricultural Research, to finance a scheme for more intensive study of the causes and best methods of dealing with parasitic disease in such areas.

In Baluchistan liver-fluke is reported to have been responsible for 74 per cent. of the total recorded mortality, and it is clear that extensive local investigation is required, in this area also, to ascertain the best means of dealing with the problem under the conditions of live-stock maintenance which exist there, when suitable staff and facilities for such work are available.

In Burma sickness and mortality from rinderpest were considerably reduced, but foot-and-mouth disease was wide spread and caused a great deal of sickness and considerable mortality.

The treatment of surra in equines and camels, by the intravenous injections of suitable doses of Naganol, was carried out on a large scale, particularly in the Punjab, and this method of treatment is already proving a great boon to owners in areas subject to periodical flooding, where conditions are favourable to the propagation of the insect vectors of the disease.

3. Veterinary Research and Investigation.

IMPERIAL INSTITUTE OF VETERINARY RESEARCH, MUKTESAR, AND THE IMPERIAL VETERINARY SERUM INSTITUTE, IZATNAGAR.

Rinderpest. Systematic testing of the various vaccines used in other countries was continued at the Imperial Institute of Veterinary Research, Muktesar, but the results so far have not been sufficiently encouraging so far as Indian conditions are concerned, to warrant the extensive employment of any of these methods of control in the field.

2. Attempts to develop a satisfactory potency test for anti-rinderpest serum have also not proved satisfactory but it is hoped that, as a result of investigations into the quantitative relations of the serum proteins, concentration of antibodies may be possible.

3. An important observation was made in the course of routine testing of anti-rinderpest serum, *viz.*, that in a case of rinderpest in a hill bull, which had died 74 days after inoculation with rinderpest virus, lesions of chronic rinderpest were found and the spleen proved to be infective on inoculation.

4. Other experimental observations showed that, even among highly susceptible hill bulls, rinderpest does not spread rapidly by ordinary contact with affected animals, however close, and that such animals are only infective for a few days following the initial access of fever.

These observations are important in regard to the practical application of control measures against this disease and are being published.

5. Work was continued on vaccines for the control of contagious equine abortion, haemorrhagic septicaemia and anthrax, and promising results were obtained from experiments undertaken with a view to improving the potency and safety of some of the vaccines hitherto employed.

6. Other work, on the presence of toxic metallic salts in sera, showed that enamel or shellac-lined vessels are the most useful for storing such substances over long periods.

7. Work was continued in the special Johne's disease herd, maintained at Muktesar for the investigation of this disease, and other investigations, carried out in the autumn of 1931, showed that a schistosome resembling *S. spindalis*, Montgomery, was present in specimens of tissues taken from all of the cases of bovine nasal granuloma available at the Muktesar Institute for examination. This work has since been confirmed in the laboratories of veterinary colleges in India and has been published.

8. Other investigations were made into a peculiar form of congenital blindness in calves, extensively met with in certain areas ; upon the etiology of Bursatee ; and on pasteurella recovered from animals suffering from a form of pneumonia.

9. Helminthological studies for the control of fluke disease, carried out in collaboration with the Director, Civil Veterinary Department, United Provinces, showed that the snail *Limnaea acuminata* was the intermediate host of *Fasciola gigantica*, which causes heavy mortality of cattle in the Kumaon hills, and that this snail could be successfully destroyed by the ordinary methods adopted for fluke control, while Danistol was highly efficient in removing these parasites from their animal hosts.

10. Other helminthological studies, upon parasites from cattle, elephants, goats and sheep, resulted in the discovery of a new round worm in a high percentage of cases of the goat pneumonia commonly met with in the hills.

11. The study of the disease due to *P. gibsoni* in dogs was continued, and observations were made on the transmission of *Anaplasma marginale* and on the treatment of these diseases with a number of the newer drugs now available.

12. The occurrence of a large piroplasm resembling *Babesia sergenti* in goats was recorded for the first time in India.

13. Malarial parasites (*Plasmodium bubalis*) were also found in the blood of buffaloes.

14. Work was continued on the prophylaxis of experimental surra in equines, and to perfect a serological test for this disease.

PUNJAB VETERINARY COLLEGE, LAHORE.

15. Observations were made, in the Physiological Section, on the safe doses to employ and the therapeutic effects of a number of new drugs, in the treatment of specific fevers and helminthiasis in dogs.

16. In the Hygiene Section an investigation, commenced in January 1930, into the milk supply of Lahore was completed and an exhaustive report submitted to the Board of Economic Enquiry, Punjab.

17. In the Anatomy Section work was continued in preparing notes and text-books on the anatomy of the ox, regarding which more intensive instruction was recommended by the Royal Commission on Agriculture in India.

18. In the Medicine Section observations were continued on the routine employment of urinary tests for confirmatory diagnosis in certain diseases, and on the etiology of peculiar local conditions met with in certain areas. Further progress was made in the investigation of indigenous plants employed in veterinary medicine and some were found to contain active principles likely to be of value.

BIHAR AND ORISSA VETERINARY COLLEGE, PATNA.

19. Observations on nasal granuloma, made at this College during the spring of 1932, confirmed the findings, previously made at Muktesar, of schistosomes and schistosome eggs in the nasal growths which are the main feature of this disease.

BENGAL.

20. In Bengal field experiments were undertaken in the use of the Muktesar fixed goat virus of reduced virulence, instead of bull virus, for the serum-simultaneous method of protection against rinderpest, and a number of young cattle of pure Indian blood were satisfactorily immunised by injections of this virus alone, in the course of a test of the safety of this method of vaccination for field work in the Province.

MADRAS VETERINARY COLLEGE LABORATORY.

21. ***Pathological Section.*** Laboratory experiments were undertaken for the study of the methods of infection and of immunization against anthrax and, as a result of further work on bovine lymphangitis, the organism associated with this disease was identified at the Lister Institute, London, as *B. pseudo-tuberculosis rodentium.*

Observations were also made on Pseudo-fowl pest and on the transmissibility of sarcomata and carcinomata in animals.

22. The production of rinderpest virus was continued and arrangements were made to test the feasibility of manufacturing anti-rinderpest serum in Madras throughout the year.

Work undertaken to test various vaccines used for the control of rinderpest in other countries had to be discontinued, however, because of an outbreak of foot-and-mouth disease among the experimental animals.

23. ***Parasitological Section.*** An extensive study was made of the seasonal incidence of cercariae in freshwater Mollusca, and new cercariae were found ; while the life-histories of *Paramphistomum cervi* and *Pischoederius elongatus* were worked out.

24. The finding at the Imperial Institute of Veterinary Research, Muktesar, of schistosomes in cases of nasal granuloma, previously mentioned, was also confirmed at this College, in the spring of 1932, and a number of fresh parasites were added to the museum collection.

25. Experimental observations were made on the transmission of surra and on other trypanosomes met with in Madras, and controlled tests were undertaken in the medicinal treatment of trypanosomiasis by means of Bayer 205 (Naganol), and of Theileria and other piroplasma infections with a variety of drugs.

26. In the Entomology Section a survey of the cattle ticks of the province was undertaken.

CENTRAL PROVINCES.

27. During the year valuable observations were carried out on a field-scale with highly encouraging results on the vaccination of

plains cattle against rinderpest by means of goat virus, originally obtained from the Imperial Institute of Veterinary Research, Muktesar. These observations confirm similar observations on a smaller scale carried out in other provinces, and give hope that the process may be of great value in field immunization against rinderpest in areas where the cattle are highly resistant to this disease, as is usually the case in the plains of India.

UNITED PROVINCES.

28. Observations on the fluke control, carried out in collaboration with the Muktesar Institute, have already been referred to.

CHAPTER VI

1. LIVE-STOCK BREEDING.

Cattle-Breeding.

In most provinces during the period under review difficulty has been experienced in carrying on the work already undertaken for the improvement of live-stock, and district boards, owing to financial stringency, were in many cases unable to take the bulls which had been specially bred for them on Government farms. Consequently Government farms have been financially embarrassed by having to maintain bulls beyond the normal period, since there is no demand for such bulls in the ordinary market, and this has become a serious matter both for the farms and for the steady progress which is essential in all live-stock breeding. It is obvious that, it the supply of improved bulls is not maintained, there is no option open to the breeders but to use such inferior animals as are available otherwise, and much of the advantage gained by the previous use of superior bulls is thus lost. Since most district boards receive grants from the Government for the improvement of stock and in some cases derive considerable revenues from cattle fairs, it seems clear that some arrangement should be made by which the bulls specially bred on Government farms for the use of district boards should be issued when ready for service in accordance with arrangements to be made by the provincial organization for the improvement of live-stock. Unless some system is put in force to ensure continuity, whenever financial stringency arises a severe check is likely to occur in the systematic improvement of live-stock which, to produce results of any significance, must be continuous through a number of generations.

The breeding of cattle for draught still continues to be the main interest of the ryots throughout the country, but interest in the improvement of cows for dairy purposes is increasing and the demand for suitable bulls of the milch breed in certain areas has been greater than could be met from the numbers available. This

is an encouraging feature because, in the absence of a local market for beef, the successful development of live-stock industry in India must depend very largely on the development of a dairy industry apart from that which already exists near the big cities.

According to a careful estimation recently made by the Imperial Council of Agricultural Research the cash value of the dairy products of India amounts, even in the present undeveloped state of the industry, to over Rs. 800 crores a year, and medical opinion is unanimous that, in the interests of the health and development of the people, the consumption of such products ought to be at least doubled.

This industry is therefore one of the most important individual industries of the whole world and one on the industrial development of which far greater expenditure of public funds would be warranted than at present.

Figures recently obtained from the Military Dairy authorities show moreover that, with proper breeding control and management, some of the best Indian breeds may be very rapidly graded up, by selection, in butter-fat and milk yield and that such improved pure Indian dairy cattle are the most economical producers of milk and butter-fat in India at present. Their results show that buffaloes are able to compete favourably with ordinary cows, and possibly with improved cows, only in areas where an abundance of coarse forage is available, but otherwise high grade cows of Indian milch breeds are already, after only a comparatively few years of selective breeding, able to hold their own, under suitable conditions of management, in regard to the over-all cost of milk and butter-fat production. Pure-bred Indian cows producing up to seven or eight thousand pounds of milk in a lactation, are to be found and this is recognised by practical dairymen in other countries to be as high an average yield as it is usually possible to maintain in commercial dairying, since the very high-yielding cow, owing to loss of constitution, increased susceptibility to disease, sterility and other factors, is not generally so suitable for the ordinary conditions of dairying. It seems, therefore, that with proper development there is no reason

why suitable pure-bred Indian milch cattle should not very soon be graded up, by selection, to compete favourably with imported and cross-bred cattle, taking into consideration the extra expense involved in the importation of bulls of European blood, and the difficulties which arise, in regard to increased susceptibility to disease and the disposal of cross-bred cattle, which in any case should not be retained for breeding purposes.

In the PUNJAB, work was continued to segregate out milking strains of two types from the existing herds, *viz.*, the white Hariana type and the grey Hissar type, and quite encouraging yields have been obtained in some of the best cows thus selected. This work is of importance since it is evident that good milking strains exist in both of these breeds and there is a definite shortage of the Hariana type in particular, as milch cattle owing to the constant drain on the best cows, which are sent to big cities such as Calcutta and Bombay and usually go to the butcher after completing one lactation. Consequently there is a definite danger that the best milk strains will eventually be lost unless adequate official steps are taken to encourage preservation of breed by systematic breeding of the best strains available.

One of the difficulties in carrying on work of this kind, at isolated farms such as Hissar for instance, is the difficulty of disposing of milk and dairy products at satisfactory prices, and this is a matter which local Governments should take up with a view to developing co-operative measures for collecting milk in rural areas, where there is no city demand, and disposing of it to the best advantage either as fresh milk, condensed milk or in some other form.

Work was continued on the grantee farms on the same lines as before and in one case, where a pure Sahiwal herd is maintained, valuable breeding bulls were made available free of cost for employment as stud bulls in suitable areas. On other grantee farms the results have not been generally satisfactory, but a scheme is now being developed to improve the class of cattle on small holders grants by supplying suitable bulls at Government expense for the service of selected cows.

In these operations, cows giving 2,000 lbs. of milk only in a lactation had at first to be accepted because better cows were not readily obtainable but already, with better feeding and care in mating, such low-yielding cows are being rapidly eliminated, and yields as high as 7,679 lbs. in a 300-day lactation have been recorded.

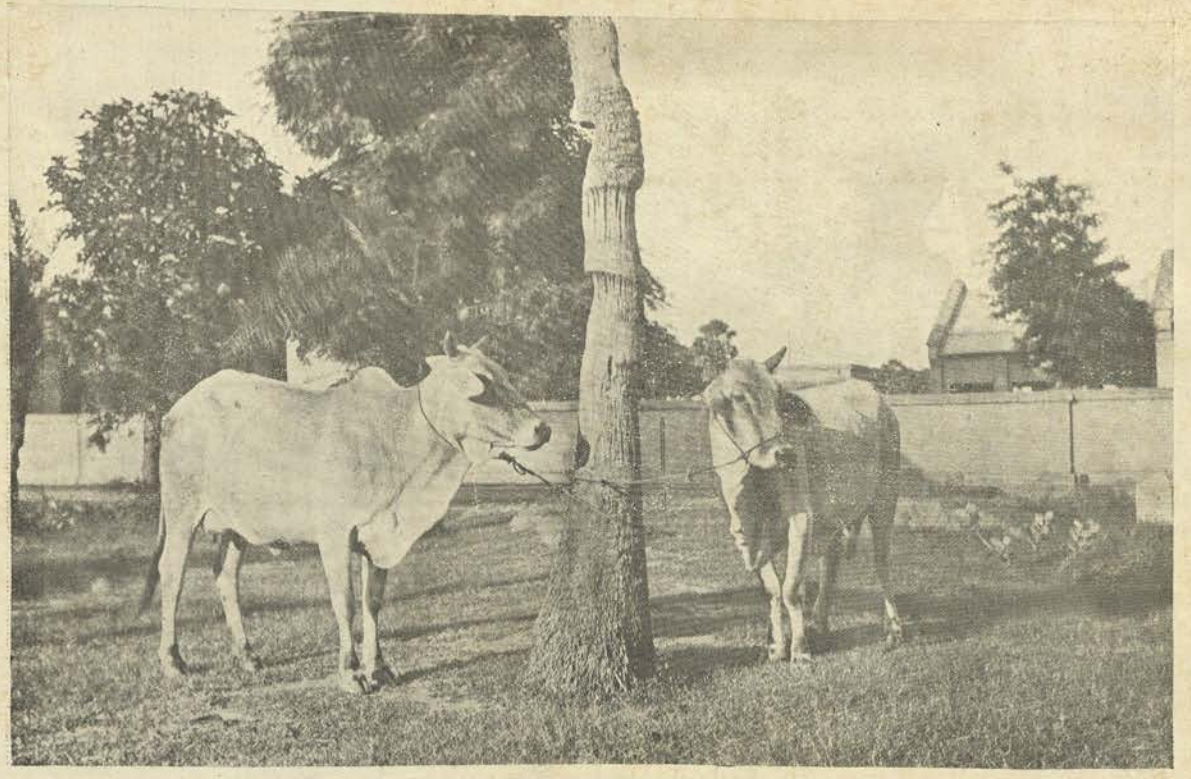
One-day village cattle shows, in which cash prizes are awarded to owners of selected cows, bulls, or young stock, are said to be a great success also, as breeding propaganda, in districts where it has been possible to take up such work.

In BIHAR AND ORISSA breeding work was continued at the cattle-breeding farm attached to the Patna Veterinary College on the same lines as before, but the lives-tock improvement work undertaken by the agricultural department has been much interfered with owing to financial stringency. Sahiwal cattle are said to develop satisfactorily in the province and as much as 7,000 lbs. of milk in a 360-day lactation has been secured, while the average yield of the cross-bred Thar-Parkar Desi herd maintained at the Patna Veterinary College has improved considerably during the period under review as the result of selection combined with scientific management.

The number of castrations carried out by the Veterinary Department during the period under review was greatly increased, but the number of stud bulls available for service is still much too small to have any appreciable effect. About 50 bulls have been distributed in North Bihar during the past 3 years and there were 56 stud bulls at veterinary hospitals in 1930-31. The total number of cattle in the province is however 21 millions and far greater numbers of improved bulls will be required before much effect can be produced.

Photographs of 2 typical Desi cows from this herd are shown in Plate II.

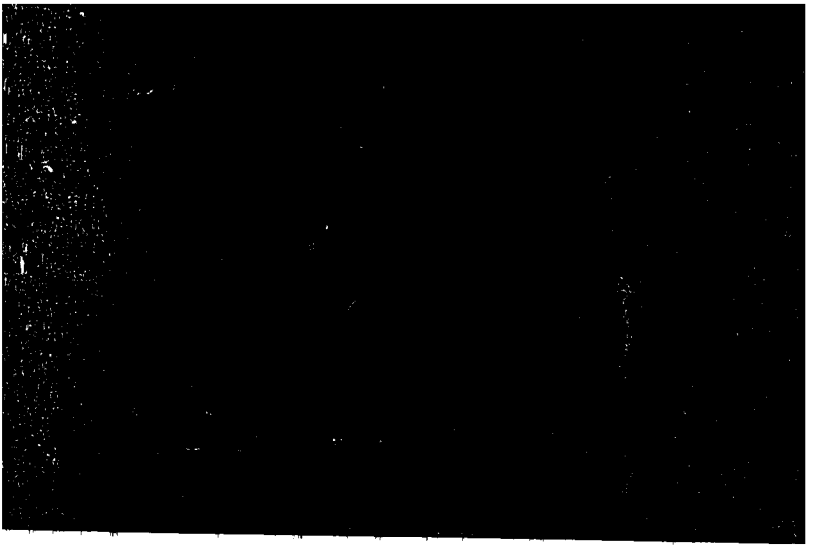
In MADRAS, pure herds of Ongole, Kangayam and Sindi cattle are still maintained, but the numbers are too small to have any adequate effect in the improvement of the 22 million cattle in the province, and cross-breeding was still in progress at certain



DESI COWS : PATNA CATTLE-BREEDING FARM.

Reproduced from the Annual Report of the Civil Veterinary Department, Bihar and Orissa, 1929-30.

PLATE II.



CORRIGENDA.

Page 203, line 10 from bottom: *For* ‘peremial’ *read* ‘perennial’.

Page 203, line 11 from bottom: The word ‘and’ should be *deleted.*

farms though experience has shown that degeneration begins to show itself in the second and subsequent generations.

There were in all 82 approved premium bulls of which 50 were farm-bred. 25 stud bulls were maintained at district farms but the number of such bulls issued during recent years has shown a steady decline and it is stated that fewer indents for bulls are being received from district boards.

Funds for the development of dairying were not available but the premium bull scheme is said to work well and there were altogether 30 such bulls in the province.

Imported Sindhi cattle are said to do fairly well but it is difficult to maintain the progeny up to the original standard.

In BOMBAY there were 92 Government bulls at work in the province in 1930-31, an increase of 13 from the previous year, and an improvement is said to be noticeable among the cattle now being produced in the areas in which improved bulls are concentrated.

At the Northcote Cattle-breeding Farm, Chharodi, outbreaks of disease and the poor season were responsible for a check in the improvement of milk-yielding Kankrej cattle bred on the farm. Yields as high as 4,500 lbs. were obtained but no advance was observed in the development of early maturity, which is one of the objects aimed at.

In SIND the grading up by selection of Red Sindi cattle was continued at the Willingdon Cattle Farm and proposals are under consideration for establishing breeding farms for Bhagnari and and Thar-Parkar cattle in tracts under perennial irrigation; but very extensive areas are available in the dry tracts in which hardy cattle can still be bred in large numbers and at low cost.

In ASSAM efforts are being made to improve the local breed and a certain number of Sindi and Thar-Parkar cattle which are not too big to mate with local cows are employed for breeding purposes. Disease due to parasitic infestation and other local causes is, however, a difficulty in this province which is not easy to overcome under the extraordinarily wet conditions which prevail during a great part of the year.

Other breeding.

SHEEP. The grading up of Bikaner sheep is being continued at the Hissar and certain other farms and results are very encouraging both in the improvement of type and in the staple of the wool produced.

The corss-bred Merino sheep which have been bred for some years at Hissar have now been made over to the Kangra Valley in the hope that they will withstand the climatic conditions of this more elevated area better than those of the plains.

HORSES AND DONKEYS. Horse and donkey breeding was also continued, particularly in certain areas in the Punjab and the United Provinces, and the successful measures which are now available for the treatment of Surra are likely to have a beneficial effect on horse-breeding, because breeders located in many of the most suitable areas could not afford in the past to keep good mares for breeding purposes, owing to their liability to die from this disease.

CAMELS. A certain amount of attention was also given to camel-breeding, particularly in the Ferozepore area of the Punjab, where the importance of the camel for work in connection with agriculture is said to be increasing.

POULTRY. More attention was given to poultry-breeding in most provinces and considerable success was obtained both in cross-breeding with European breeds and in the development of fixed types of cross-breds between such breeds and certain of the better defined Indian strains such as the Chittagong and Asil fowls, while Busra fowls have continued to prove particularly suitable for such cross-breeding. A certain amount of good work has also been done, particularly in the Punjab, in selecting and grading up suitable Indian birds by selection, but much more attention to poultry breeding and poultry diseases is required throughout India.

GOATS. During the period under review selective goat-breeding was continued at Hissar and one or two other farms and the progeny appeared to be very promising but difficulty was experienced at Hissar owing to a severe outbreak of contagious abortion.

Sanction was given by the Imperial Council of Agricultural Research for a grant to assist the Etah Mission Farm in grading up by selection two pure Indian breeds and to carry on a limited amount of cross-breeding with imported Toggenberg goats, a certain number of which were already available at the farm. The milk-yields of these goats will be carefully recorded and their pedigrees registered with a view to building up true breeding types of the two Indian breeds, and the results so far obtained are very encouraging. There is likely to be a considerable demand for such improved goats for breeding purposes in this area, which has in the past exported a number of such goats to other countries.

2. DAIRYING.

Work was carried on during the period under review at Bangalore, Wellington, Anand and Karnal on the same lines as previously, and it is gratifying to note that there was a considerable increase in the number of students under training for the Indian Dairy Diploma. This is most important work for the development of a scientifically conducted dairy industry in India and should be encouraged in every way possible. Twenty-seven students were trained during the year 1929-30 and 22 passed the final examination. Financial considerations however interfered considerably with the development of the industrial research into dairying practice which is so essential for the proper development of the industry.

Some investigations were carried out at the Anand Creamery regarding long distance transport of milk for city supply and regarding the manufacture of dairy products, but expert staff is required to enable this work to be dealt with satisfactorily and provision for this is now being made by a grant from the Imperial Council of Agricultural Research.

Special breeding work was continued at the Karnal Farm but it is clear that similar work, for the improvement of indigenous breeds of milch cattle, requires to be extended all over the country since results obtained during recent years in Military Dairies show that most striking improvement in such cattle can be obtained by

selective breeding and scientific dairy-herd management. For the practical benefit of the dairying industry throughout the country this is a much sounder line of development than any system of cross-breeding with European breeds, the benefit of which is likely to be only temporary and the harm resulting from indiscriminate cross-breeding incalculable.

The demands made on the office of the Imperial Dairy Expert for technical advice, from all parts of the country, showed no diminution, while most provincial governments and the larger Indian States made some effort to encourage the improvement of their milch cattle.

Co-operative Societies' Milk Unions made further progress in Dacca, Chittagong and Calcutta, under the guidance of the dairy section of the department of the Registrar of Co-operative Societies, Government of Bengal; and the Co-operative Department of the Government of Mysore completed a survey of milk-supply to Bangalore with a view to the erection of a modern co-operative milk factory in that city.

Experimental work was carried out under the Imperial Dairy Expert, in the manufacture of cheddar cheese by means of a purely vegetable coagulant; in the neutralisation of sour cream for butter making; in the pasteurisation of milk by various types of machines; on the percentage of the loss in milk pasteurisation and in the manufacture of ghee, rennet and lactic acid casein. Observations were also made on the percentage composition of milk yielded at different milking periods and the quality of milk obtained at different stages during the process of milking. Available records were also systematically studied with a view to determining average dry periods of various types of Indian cattle under varying conditions, post-graduate students being made use of in carrying out this work as a part of their course of training.

At the Anand Creamery work of a scientific nature was much hampered through the want of new machinery and buildings, particularly a milk-drying plant and a students' hostel, which are essential for the proper development of scientific research and instruction in modern dairy practice in India.

It is reported that during the period under review something like 50 per cent. of the herd at the Bangalore Dairy Farm were used for nutrition research and it may be pointed out that, though this is most valuable work in no way to be discouraged, it must necessarily have a very adverse effect on the results obtained from the milking herd.

The Central Bureau of Animal Husbandry continued to deal with large numbers of enquiries regarding cattle-breeding and dairying from breeders in and outside India and a number of pure Indian-bred cattle were supplied to breeders from the farm herds at Karnal, Bangalore and Wellington.

Propaganda work was continued by this Bureau and dairy films were supplied on loan to the Indian State Railways and to other institutions.

Short courses of practical training varying in length from 3 to 6 months were given at Bangalore, Wellington and Karnal and at the Anand Creamery, to 45 candidates from private organizations, Provincial Governments, and the Allahabad Agricultural Institute, while 4 British soldiers were given vocational training in dairying at the request of the Military authorities.

It is reported that, for the first time in the history of the institution, applicants for admission to the course of the Indian Dairy Diploma were far in excess of the number which could be taken with the limited hostel accommodation available. This is most encouraging as conclusive evidence of the popularity of the course, and instances are not wanting which show that students trained at this Institute are doing really good work in the country.

Mr. F. J. Warth, the Physiological Chemist to the Government of India, and his staff continued to work in close co-operation with the Imperial Dairy Expert and were of great assistance in the training of students and in the analysis of feeding stuffs used at the farms.

During the period under review a number of schemes for the opening of dairy farms by private individuals were examined and advice given by the Imperial Dairy Expert thereon, and it is significant that amongst the enquirers were a number of institutions,

such as *Pinjrapoles* and *Gowrakshas*, maintained for the benefit of abandoned cattle, which with the assistance of trained dairymen are now developing remunerative dairy businesses capable of doing much to save valuable milch cattle from the butcher and to improve indigenous breeds by the use of suitable sires.

In the course of the period under review advice was given to enquirers from practically all of the larger provinces and States throughout India and to applicants from a number of foreign countries and there is no doubt that work of this nature is very much required for the development of scientific dairying in India.

3. ANIMAL NUTRITION.

Work has been continued on the investigation of nutrition problems in different parts of India and two new sub-stations paid for by the Imperial Council of Agricultural Research were sanctioned during the period under review, but the proper study of the nutrition of India's 300 million domesticated animals is a matter of huge economic importance and far more work of this nature is necessary throughout India in the interests of stock-owners of all kinds.

No change was made in the staff under the Physiological Chemist and large numbers of analyses were made of fodders, faeces, urine and soils, for the systematic examination of Indian fodders and in connection with feeding experiments.

Observations on the nutrition of growing animals showed that gram husk in certain circumstances could be used as a substitute for wheat bran, both of which brought about approximately equal increase in weight, and improved the consistency and palatability of the ration, though digestion experiments showed that gram husk has a distinctly lower starch equivalent value than wheat bran and contains no digestible protein whatever.

Calf-feeding experiments carried out at the Hosur Farm strikingly demonstrated the enhanced value of early-cut hay, the increase in live-weight in 100 days in calves fed on early-cut hay being more than twice as much as those fed on mature hay, the amount of concentrates consumed being equal. It was concluded that the

better productive power of early-cut hay was due partly to better consumption and partly to its high palatability. These experiments are of considerable practical importance as they indicate a line on which the nutrition of cattle in India might be much improved at little extra expense.

Other experiments carried out on growing heifers appeared to show that no greater advantage was obtained from a mixed ration, of 2 fodders, than was obtained from either of these 2 fodders fed alone, and further work on the feeding values of common oil-cakes has been published.

Arrangements were also made to carry out extensive observations on the rationing of dairy cows for milk production in collaboration, with the Assistant Controller of Southern Circle, Military Dairy Farms.

Feeding trials, to determine the relative merits of high and low silage feeding and the examination of typical hays were continued and the results so far obtained have been published. These trials indicate a very wide range of protein-content which was found to fluctuate between 18·0 per cent. and 1·9 per cent. and was attributed mainly to (*a*) characteristics of the species and (*b*) the stage of maturity. Graphic representation of the data thus collected revealed that the digestibility of all ingredients in the fodder is related to its protein-content and based on these results a graphic method was developed for estimating the nutritive values of fodders and is being published.

Observations on the effect of maturation on the nutritive value of hay showed that the amount of digestible protein and the starch-equivalent-values decreased steadily in all cases as maturity advanced.

With a view to going further into this matter, arrangements were made between the Physiological Chemist and officers of the Imperial and Provincial Departments of Agriculture to grow a number of pure species of pasture grasses, on selected sites in different parts of the country, representing the chief soils and climatic conditions met with. The work on protein digestion which had been in progress in previous years was completed and is being published.

A thorough examination was also carried out of *Jowar* cut at different stages of development and preserved under different conditions of packing, while other observations showed that no advantage was gained from ensiling *ragi* straw.

In the course of studies on diuresis it was found that certain animals always gave exceptional results and a scheme was organized to determine how far such anomalous urination affects metabolism.

Further work was carried out during the period under review on hippuric acid excretion, on the acid-base-balance of cattle urine, and on sulphur metabolism ; post-graduate instruction was given to four students, and a research student went through a course of training at the Institute.

A fresh proposal to establish an enlarged Nutrition Institute for all-India was taken up by the Imperial Council of Agricultural Research and a plan was prepared with a view to taking over the old X-Ray Institute at Dehra Dun for the purpose, but financial considerations prevented any further progress with this proposal.

CHAPTER VII.

VETERINARY EDUCATION.

During the period under review the new Veterinary College at Patna was completed and the first batch of students was admitted in July 1931 ; while the colleges at Lahore, Bombay, Madras and Calcutta continued their courses of veterinary training as before though, owing to financial stringency, a reduction of the course of training at the Lahore College from 4 to 3 years was under consideration.

Such a reduction would be a retrograde step, much to be regretted in the interests of veterinary education in India, and an endeavour was made by the Education, Health and Lands Department of Government of India and the Imperial Council of Agricultural Research, to carry out, as far as possible, the recommendations of the Royal Commission on Agriculture in India in this matter. The establishment of a superior college to train up to the M. R. C. V. S. standard was an essential part of those recommendations and the intention was to introduce new curricula, for the best course of training possible in a three-year course of instruction at all other veterinary colleges in India. It was, however, ascertained that there was little prospect of these measures being adopted in the near future, and the matter has been again referred to the Imperial Council of Agricultural Research by whom an alternative proposal was circulated to provincial governments, suggesting that the standard of veterinary training might be improved and made more uniform at small expense, if all the existing colleges would adopt the F.Sc. (Medical Group) Punjab or equivalent standard as the entrance qualification necessary for admission.

This proposal is now under further consideration and it is hoped that in the near future the revision of the present curricula will be undertaken by a committee of experts.

Bombay Veterinary College. There were 104 students on the rolls on the 1st of April 1929, and 130 on the 1st of April 1930. Of the former number 66 and of the latter 85 passed their examinations successfully. The number of students who passed their final

examination and left the college was 23 in 1929 and 19 in 1930; while 64 new students were admitted during 1929 and 50 during 1930. There were altogether 130 students on the rolls at the end of the year 1929-30 and 137 at the end of the year 1930-31. In the former year 8 new scholarships were awarded, seven to students belonging to the presidency proper and one to a scholar from Sind, making a total of 14 scholars in all. In the latter year 6 scholarships were awarded to students from the presidency proper and 5 to students from Sind, making a total of 14 scholars in all.

Of the graduates who passed in 1929, 13 are in the service of Government or local bodies, 9 are in the service of Indian States, and 2 are unemployed, while of the students who passed in 1930, 14 are in the service of Government or local bodies, 3 are in the service of Indian States and 2 are unemployed.

BENGAL VETERINARY COLLEGE. The demand for admission into the College from in and outside Bengal is stated to be increasing year by year.

At the beginning of the 1929 session 176 students were on the rolls, of which 163 continued their studies throughout the year, while at the beginning of the 1930 session 167 students were on the rolls, of which 141 completed the scholastic year.

The number of new students admitted into the College during 1929 and 1930 was 49 and 81 respectively. In consequence of the opening of a new Veterinary College at Patna in July 1930, the Government of Bihar and Orissa have withdrawn all their students from the Bengal College, but this factor did not affect the number of fresh admissions to this College seriously.

The number of students who held stipends was 112 in 1929-30 and 64 in 1930-31.

PUNJAB VETERINARY COLLEGE. Of the 122 candidates who offered themselves for admission to the College in September 1929, 61 were admitted, and of the 40 candidates who presented themselves for admission during September 1930, 36 were taken. As the standard of admission was raised to the Intermediate Standard in the Science or Arts Faculty, no Matriculates could be admitted and it is anticipated that there will not be much difficulty in obtaining F.Sc. (Medical Group) students in sufficient numbers in future.

The number of students at the end of the years 1929-30 and 1930-31 was 171 and 192, respectively.

The number of students who passed their final examination and left the college during 1929 was 38, and 42 during 1930.

Farriers' classes were continued during the period under review and 27 candidates passed in 1929 and 28 in 1930.

MADRAS VETERINARY COLLEGE.—In accordance with the recommendations of the Royal Commission on Agriculture and with a view to raising the standard of education, a revised curriculum has been introduced in this College with effect from the 1st July 1930.

The period of study under the new curriculum remains the same as hitherto, *viz.*, three years, but the curriculum is designed to provide a basic training in most of the essential subjects pertaining to veterinary science and the subjects have been redistributed among the 3-year classes. An important feature in the new curriculum is the prominence given to the study of cattle and the changes introduced into the subjects of comparative anatomy, the ox being taken as the standard instead of the horse.

The preliminary educational standard for admission to the College under the new curriculum is S. S. L. C. with 45 per cent of the marks in English, but in order to induce young men with higher educational qualifications to join the College, 14 of the 40 seats have been reserved for Intermediates and 6 for Science Graduates. On appointment to the department, three years' seniority for pay will be given in the case of Intermediates and five years' seniority in the case of Science Graduates. These men are not however given stipends as they will be started on a higher initial pay than the ordinary S. S. L. C. holder.

The number of students at the College has increased from 98 in the previous year to 109 on the 31st March 1930 and 117 on the 31st March 1931. Forty new students were admitted to the College in 1929 and 43 in 1930, the three students selected in excess of the usual 40 being admitted as extra non-stipendiaries, nineteen students passed the final examination in 1929 and 27 in 1930.

BIHAR AND ORISSA VETERINARY COLLEGE, PATNA. This College was started on the 1st of July 1930 and all the students from this

Province were transferred to Patna from the Bengal Veterinary College. The Patna College opened with 34 students, including 24 transferred from the Bengal College, Belgachia, and 18 more joined subsequently, making a total of 52 in all. The number on the roll at the end of the session was 49, of which 45 held stipends. Ten students passed the Diploma Examination from this College in 1930-31.

INSEIN VETERINARY SCHOOL. There were 13 students on the roll on the 1st April, 1929, all of whom passed the final examination and were given appointments in the department. During 1930-31, however, instruction was confined to Veterinary Assistants on Refresher Course, two such courses being held.

The re-opening of the College is held in abeyance pending decision of the Government on the reorganization of the department.

The numbers of students under training and who passed their final examinations during the period under review, at the different colleges in India, are shown in Appendix XI.

IMPERIAL INSTITUTE OF VETERINARY RESEARCH, MUKTESAR. It having been decided by the Government of India that an advanced post-graduate course for veterinary officers should be held only once in two years, no such course was held in the year 1929-30, but 9 officers attended the Institute at different times for short periods and were given practical instruction in all technical matters undertaken at the Institute.

During the year 1930-31 a post-graduate refresher course of 10 weeks' duration was held for officers of the Royal Army Veterinary Corps, Indian Veterinary Service and Superior Provincial Veterinary Services and four officers attended this course.

Later in the year sanction was given by the Government of India to throw open this course to officers of the ordinary provincial services and it was also decided that the course should be held annually in future if sufficient numbers of students were available.

Nine post-graduate students took practical courses at the Institute, of varying duration, and a research scholar from the Punjab joined the Institute for a 2 years' course of training.

CHAPTER VIII.

DISTRICT WORK.

This chapter deals with the greatest of all agricultural problems, to make new knowledge into common knowledge and to bring practice into conformity with that knowledge. The figures given in the preceding chapters illustrate the extent to which improved crops have been introduced and this one will deal with other improvements that are becoming part of the general agricultural practice of the country. Well-organised propaganda and extension work including arrangements for the supply of seed, implements and manures which in many countries is left to private agency are the means by which this object is being brought about. Indeed, the task of the agricultural departments in India is only half finished when research and field-experiments have proved the value of some new crop or method; the improvement has still to be brought to the notice of thousands of small farmers, mainly illiterate and men of small resources, and the department must often act as seedsman or manure-seller at least until a supply organization can be built up such as is discussed in Chapter X. Progress in the introduction of new crops can be judged to some extent from the figures given in Chapter II showing that the ascertained area was over 13·4 million acres in 1930-31 as compared with 12 million acres in 1928-29. Progress in the introduction of improved implements is much more difficult to gauge, since the sales by and through the departments represent only a fraction of the total sales. Several firms are now actively engaged in implement manufacture, whilst many of the simpler implements are made, to an extent dfficult to estimate, by small firms and individual artisans. To form any real estimate of the extent to which improved methods of cultivation have been taken up is still more difficult. During the early stages of the demonstration of such improvements some idea can be gained of the rate at which they are being adopted, but this stage is soon passed. Moreover, as demonstrating staffs gain the confidence of the cultivator their advice is taken on a variety of matters and the aid of the

department is sought in many directions. More important than the introduction of any single material improvement is the gradual and almost indefinable change in the outlook of the cultivator, and his recognition both of the existence of a department of Government which can assist him and of the fact that it is possible to raise the efficiency of his agriculture by the application of new methods. Such changes cannot be reduced to figures. That they are taking place is clear to many who in one capacity or another have been associated with the work of the agricultutal departments and who have seen the scepticism of 25 years ago replaced by an active faith. For nó province, much less for India as a whole, is it now possible to measure the agricultural standard of one year against that of its predecessor. All that can be done is to review the organisation and methods employed and to comment on new developments and on the relative effectiveness of different methods of bringing agricultural improvements to the villages.

1. Demonstrations.

Demonstrations on the cultivators' own lands under village conditions is the method of introducing agricultural improvements on which all agricultural departments still place most reliance. It brings the demonstrators into closest personal touch with the cultivators; they acquire a thorough knowledge of local conditions and so can give attention to details on which so much depends for the success of the demonstration. In MADRAS, the policy was adopted of concentrating the work of each demonstrator so that he could intensify his activities on four or five villages at a time, instead of covering a large area. Fewer items of propaganda were taken up and attention was paid to the more fundamental items such as clean cultivation, preservation of cattle manure, making of composts, care of cattle, use of pure seed and of improved implements and the preservation of land from erosion. In 1929-30, 6,200 demonstrations were carried out, a decrease of 860 from the previous year and in 1930-31 2,000 were made. The differences for the better were obvious in all cases but the profits were rendered less attractive by the fall in prices. In BOMBAY 1,468 demonstra-

tions were carried out in 1929-30 which is 301 more than in the previous year, and 1,610 in 1930-31. In addition a large amount of propaganda was carried on by the taluka development associations and co-operative societies, and the 124 past students of the Devihosur School working in their own land served as excellent propagandists. During both years, too, an effort was made at concentrated mass propaganda in the two districts of Ahmednagar and Sholapur. The two points demonstrated were the grading of *rabi jowar* and the adoption of methods of dry farming. The Collector, the revenue staff and the agricultural demonstrators all combined to bring about 6,000 cultivators into direct touch with the improvements. In Ahmednagar, 25 large meetings of cultivators were held in the first year and 40 in the second, while a total area of 430 acres were under demonstration in the one year and 650 acres in the other. It is said that the average increased yields were 19 per cent. for graded *jowar* and 65 per cent. due to dry farming methods.

In BENGAL 2,427 practical demonstrations were carried out in 1929-30 as compared with 2,613 in the previous year and 2,861 in 1930-31. In addition 140 private farms in the first year under review, raised to 165 in the second, served as effective demonstration centres. The District Magistrates everywhere, recognising the importance of this work, gave much practical encouragement which helped materially to its success. A good instance of such collaboration was the organisation of the collection of departmental seed from seed-farms and its distribution in Rajshahi to the cultivators of 20,000 acres whose rice crop had been badly attacked by *Sclerotium oryzae.*

In the UNITED PROVINCES, field demonstrations were mainly carried out on privately owned farms managed under the instructions of the departmental staff. This system, considered to be well adapted to the conditions of the province, has the advantage of enabling a number of demonstrations to be made at the same centre. Twenty-seven departmental farms in the first year and one more in the second were set apart for seed and demonstration purposes. The number of private farms increased from 964 in 1928-29 to 1,118

next year and to 1,240 in the succeeding year. The total area under village demonstrations including those of land rented for the purpose was 271,182 acres in 1928-29, 362,950 acres in 1929-30 and 373,204 acres in 1930-31. In the last year 324,130 acres were used for the demonstration of improved crops, 4,470 acres for green manuring and 44,604 acres for improved implements.

In the PUNJAB the number of demonstration plots laid out on cultivators' land was 1,521 in 1928-29, 2,316 next year and 2,336 in 1930-31. A majority of these plots, worked to show the advantage of improved cotton and wheat, were attended with success, the increased yields amounting to from 13 to 17 per cent above the ordinary yield of surrounding fields. The work started some years ago with the object of completely modernising agricultural methods in 293 villages was continued. In one of the Canal Colonies, a scheme was initiated to give a grant of half a rectangle, of 12·5 acres, rent-free for a period of three years, to tenants who farm their holdings best during the year, and 18 rectangles have already been awarded.

The total number of demonstrations in BURMA was 800 in 1928-29, 1,017 in 1929-30 and 1,182 in 1930-31. A special feature was introduced in the Myingyan Circle where instead of demonstrating particular items on isolated holdings, all operations of successful dry-farming were demonstrated on a few holdings. In the first year work was carried out on 18 holdings but next, year, with the help of a grant from the Indian Central Cotton Committee, demonstrations were carried out on 35 holdings involving the levelling and terracing of land, making bunds, adopting improved methods of cultivation with improved implements and using improved seed. So successful was this innovation that the yields of cotton *kapas* was from 100 to 150 *viss* instead of the district average yield of 75 *viss*. Such experiments are expected to have a very great influence on the surrounding cultivators by demonstrating that it is possible for cultivators themselves to better their own condition.

In BIHAR AND ORISSA the number of demonstrations was 6,060 in the first year under review and 8,061 in the second. In North

Bihar the "better farming campaign" was continued. Here the demonstrator equipped with a cart, a pair of bullocks and a set of improved implements simultaneously demonstrated the effects of improved cultivation, seed, implements and manures. Co-operative banks and other agencies also took a hand in this work employing 38 of their own trained demonstrators.

In the CENTRAL PROVINCES the number of demonstrations was 4,371 in 1929-30 and 4,200 next year. In addition, 54 demonstration plots were worked, 33 of which were worked by the department on rented land and 21 by cultivators on their own land under the immediate direction of the department. In ASSAM, the number of demonstration plots during 1929-30 was 1,583 as compared with 1,703 in the previous year but unfortunately half the number of plots in the Surma Valley were washed out by floods. In 1930-31 the number was 1,758. In SIND, the itinerent system of demonstration has also been found to be most useful. One-hundred-and-sixty-four villages were visited and 247 demonstrations given.

2. Peripatetic demonstrations.

In addition to the intensive method of demonstrating to the cultivator on his own land that he can make improvements on his agricultural practice, the possibilities of advertisement have been explored in several directions, *e.g.*, in using carts and motor-lorries to go round both demonstrating and exhibiting and in using fitted-up trains for exhibition. In the Punjab and in Bihar and Orissa, the carts were a special feature of demonstration that met with considerable success. In Madras and the Central Provinces the motor-lorry was being used while in Bengal and Assam demonstration trains were run. In the first method, the demonstrator, supplied with a cart, a pair of bullocks and a set of improved implements, goes round the villages when the land is being prepared or the crops sown and the success is so remarkable that not only do the cultivators sow the improved seed according to the improved method but they buy the improved implements. The two exhibition motor-vans, maintained by the Department of Agriculture in Madras, were a powerful means of attracting the attention of villagers wherever

they toured. They were specially equipped for every tour with a view to convey information on a few selected topics suitable to the particular district through which they passed and naturally the change of equipment had to be made very often. Next year a third motor-lorry was added to accommodate the demonstrator and his staff and thus give greater freedom in the choice of out-of-the-way places to visit. In the CENTRAL PROVINCES, the effectiveness of demonstration work was materially assisted by the cinema-lorry which was fitted out for each tour with the seed, implements and other things of interest suited to the tract in which it was to tour and was provided with a portable engine, which not only supplied the power to generate the current needed for the cinema projector, but at other times was used to operate a pump and fodder-cutter. Its interest-arousing ability was very great and its demonstrations were attended by hundreds of people at each place. The pictures may or may not be directly effective but there is no doubt that their attractive influence draws many a cultivator whom the demonstrator in ordinary touring would not reach and makes possible other effective demonstration work.

Demonstration trains were run for a short time but have now ceased owing to lack of available funds. There is some considerable diversity of opinion as to whether these trains are worth while, but the consensus of opinion appears to be that at present they are impracticable, partly owing to the length of each tour and partly to the difficulty of changes in languages, in staff and in agricultural methods advocated in different parts of the country.

3. Agricultural exhibitions.

In Madras the more important fairs, conferences and festivals held in each district were attended, exhibits shown and lantern lectures were given. The number of such exhibitions amounted to over 200 in 1929-30 and to about a 100 in 1930-31. In Bombay thirty-seven agricultural shows were held during 1929-30, the most important being the one organised by the Dhanu Taluka Development Association at Bordi, which was modelled on the method of the Presidency shows, the first of which was held in

Poona in 1926. The show was attended by 25,000 people. Just as many shows were held in 1930-31, the most important being the Nasik District Show which was organised by public subscription; the crop court was a special feature of this year's show, which was kept open for a week and was attended by some 40,000 people.

In BENGAL, the department subscribed during 1929-30 to 25 agricultural exhibitions, the more important of these being those held at Kalimpong, Suri, Manikanj and Jalpesh and as usual cattle-fairs and ploughing matches were held on these occasions. The number of exhibitions held during 1930-31 was less than in the previous year and the departmental contributions to them were cut down on account of retrenchment.

In the UNITED PROVINCES 91 shows were held in 1929-30, the most important being the one arranged on the occasion of the Kumbh Mela at Allahabad which was attended by several lakhs of people, but financial considerations restricted this form of activity in the following year.

In the PUNJAB all the fairs and large exhibitions in the province were attended by the district staff and the usual demonstrations were given. The agricultural stall, which was opened in the Lyallpur market in 1928, proved an excellent means of bringing the improvement of the department to the notice of the public and of establishing close contact with the commercial community. The amount of the sales and the number of visitors, 24,000 in 1929-30 and 15,000 in 1930-31, gave testimony to its popularity. All other provinces engaged in this form of activity to the extent to which funds and possibilities admitted.

4. Seed production and distribution.

In the chief rice-and cotton-growing tracts of MADRAS an extensive organisation for the supply of pure seed has been built up with the help of co-operative societies, private seedsmen and also seed-farms under the supervision of the department. The quantity of improved rice seed distributed amounted to 57,700 maunds in 1929-30 and 33,530 maunds in 1930-31. The area under seed-farms for cotton was 10,950 acres in 1929-30 and 10,920 acres in 1930-31.

In BOMBAY, seed-supply in 1929-30 was organised on an extensive scale for the cotton crop at three centres situated in the three important cotton-growing tracts. The most important development of the year was the substantial financial help given by the Indian Central Cotton Committee for this work. The best organised seed work was to be found in the southern division where the extension of the two departmental varieties, Jayawant and Gadag No. 1, was regulated at the successive stages from the small plot in the experimental farm to the ryots' fields, the initial stages being entirely handled by the department, and the last stages by the co-operative sale societies under the supervision of the department. The total amount of seed handled by the department and the co-operative sale societies of Hubli and Gadag amounted to 25,217 maunds. In Surat and Khandesh, the department distributed 31,013 maunds of 1027 A. L. F. and 328 maunds of N. R. and Banilla varieties. In SIND, 7,374 maunds of improved Deshi "No. 27 W. N." and 668 maunds of 4F American were distributed. As regards other crops, 9 maunds of wheat, mostly Pusa 12 in Sind, and 11,044 maunds of improved rice varieties were distributed to the ryots.

In 1930-31, the seed-extension schemes for Jayawant and Gadag No. 1 in Dharwar reached the next further stage and similar schemes were launched for the distribution of the Banilla cotton in Khandesh and 1027 A. L. F. in Gujarat. The Khandesh scheme, when it reaches its full development, will be the biggest cotton seed scheme so far organised in this province, and is intended to cover the whole cotton area in Khandesh with Banilla cotton. Seed operations with rice were mainly located in the Konkan and the system consisted in appointing ten registered seed-growers per taluka who were supplied with seed according to market rates on condition the department should be permitted to rogue the crop and the grower should make half of the produce available as seed. About 6,000 maunds of seed were distributed to the ryots in this manner. Similar work on a smaller scale was in progress for wheat, groundnuts, *bajri* and maize.

In BENGAL, there were 247 seed-farms aggregating 12,000 acres, from which 13,000 maunds of pure seed were distributed each year.

At Rajshahi, in particular, departmental seed was very much in demand owing to the shortage of local seed caused by the disease mentioned in Chapter III. Over ten lakhs of cane-cuttings of Co. 213 were distributed in each year.

In the UNITED PROVINCES, the number of private seed-farms was 1,118 in 1929-30 and 1,240 in 1930-31. The amount of seed distributed in the former year was 638,624 maunds and in the latter 1,059,840 maunds, about 80 per cent. of which was sugarcane and 16 per cent. wheat.

In the PUNJAB, the amount of improved cotton seed distributed was 30,455 maunds and 29,750 maunds, and of wheat 50,752 maunds and 37,200 maunds, in the two years. Great efforts were made to supply Coimbatore varieties of cane with the result that 80,000 acres were planted in 1929 and 104,400 acres in 1930. Cane setts were supplied free of transport charges to ryots on condition that the produce would be available for further propagation.

In BURMA 110 seed-farms were maintained in 1929-30 and 17 more were added next year, the aggregate area being 7,706 and 9,043 acres in the respective years. In the former year 86,980 maunds of pure seed were distributed and in the latter 117,600 maunds about 90 per cent. of which was departmental strains of rice.

In BIHAR AND ORISSA, the organisation of registered seed-growers, started in 1928, made some progress in 1929 but fell away in 1930 owing to the fall in prices. In 1929-30, 6,541 maunds of seed and 43,260 maunds of cane setts were distributed, while in 1930-31 the amounts fell to 5,715 maunds of seed and 11,366 maunds of cane setts.

In the CENTRAL PROVINCES, the total number of private seed-farms in 1929-30 was 14,273, an increase of 1,569 as compared to the previous year and again in 1930-31 there was a further increase of 1932. The amount of pure seed supplied in 1929 was 591,741 maunds of which 49 per cent. was wheat, 18 per cent. cotton and 22 per cent. rice and in 1930 showed a slight decline to 495,179 maunds, the decrease being due to the fall in the amount of wheat seed distributed which was only 31 per cent. of the total.

The chief feature of 1930-31 was the extensive rogueing, collection, ginning and marketing of Verum 262 cotton carried out with the financial support of the Indian Central Cotton Committee. Seed amounting to 62,300 maunds was sold for seed purposes and 11,162 bales of cotton were sold at an average price of Rs. 212-8-0 per candy. These operations were conducted under the direction of the Deputy Director of Agriculture, Economics and Marketing.

In ASSAM from three seed-depots, fed by the produce from selected seed-farms, 3,671 maunds of rice, 2,431 maunds of potatoes and 164 maunds of jute seed were distributed in 1929-30. Helped financially by the Flood Relief Committee, the department distributed a large quantity of seed in the Surma Valley where the standing crops were destroyed by floods, and later on too in winter more seed was distributed in the stricken areas and this made *rabi* cultivation rather popular in the Surma Valley where it is not usually practised.

In MYSORE, a seed-supply organisation has been built up for the *ragi* crop. Sixteen private seed-farms were organised and the seed obtained from them was distributed for further multiplication on 'B' farms with the help of the co-operative societies. The further distribution of the seed from the 'B' farms has been carried out largely through the co-operation of village panchayats and co-operative societies. By these means seed sufficient for 16,000 acres was distributed among the ryots in 1930-31. The distribution of improved varieties of sugarcane and cotton was also organised on a fairly large scale.

5. Implements.

In Appendix V a statement of the agricultural instruments sold through departmental agency will be found. The sales of ploughs are characterised in all provinces by one satisfactory feature, *viz.*, that sales of spare parts considerably exceed the sales of ploughs, a useful indication that the ploughs are used. The recorded sales are no real measure of the extent to which improved implements have come into use. Both manufacture and sale by private agencies is increasing and departmental sales in some cases represent little

more than the first following up of successful demonstrations. In all provinces the tendency is for the agricultural departments to devolve the supply of agricultural implements to other agencies as much as possible and to concentrate on experiment and demonstration. Co-operative organisations, however, have been disappointingly backward in taking up a branch of agricultural supply which can be run on a business footing and which is free from the risks accompanying the storing and supply of more perishable commodities. The total sale of agricultural implements through the agricultural departments amounted to 53,471 in 1929-30 and 49,998 in 1930-31 compared with 41,528 in 1928-29. The number of ploughs sold increased from 27,478 in 1928-29 to 30,396 in 1929-30 and fell to 25,513 in 1930-31, the largest increase being in the Punjab and Burma. The sales of fodder-cutters show a striking increase from 7,341 in 1928-29 to 14,510 in 1929-30 but decreased to 128,000 in 1930-31 ; the largest increase so far being in the Punjab where the number has nearly doubled. The number of cane mills also increased from 1,394 in 1928-29 to 3,302 in 1929-30 and 5,792 in 1930-31. The sale of spare parts increased from 29,848 in 1928-29 to 40,161 in 1929-30 and fell to 20,129 next year.

In MADRAS the sale of ploughs was entirely in the hands of private agencies and the Director notes that the sales have fallen considerably and that the requirements for spare parts have not been met ; so the necessity for the department's shouldering the responsibility is becoming insistent. An excellent harrow, H. M. Guntaka, was thoroughly demonstrated throughout the presidency. In BENGAL, sales of the Sobkam plough, offered at Rs. 6, are increasing and for the first time the Bengal ryot is offered an iron plough at an attractive price. In the UNITED PROVINCES the Meston plough is in great demand and 8,887 were sold in the two years. The outstanding feature of sales in the PUNJAB is the large demand for Meston ploughs, cane-crushers and fodder-cutters. It is reported that there are about 21 iron foundries working at Batala with an output of 19,000 implements of all sorts. In BURMA the chief feature is the large number of Theikpan ploughs and shares sold, especially in the East Central and Myingyan Circles. It is

reported that private blacksmiths are casting the Theikpan plough shares and that one of them has produced a type specially suitable for sandy soils. In BIHAR satisfactory progress was made with the recently designed improved implements, the Bihar plough, cultivator and ridge plough. In the CENTRAL PROVINCES the striking progress made in the earlier years in the sale of implements has now received a check, the reason being that with a general fall in the value of agricultural produce, the cultivator is disinclined to make further capital expenditure. Special attention was, however, being paid by the district staff to seeing that the ploughs which have been sold were kept in working condition and not allowed to be idle. Reference to the more recent work on the design of improved implements has been made in another chapter and to propaganda in an earlier part of this chapter.

6. Fertilizers.

No complete returns are available of the sale of commercial fertilizers and oil-cakes, but the table in Appendix VI gives the ascertained sales by agricultural departments' depots. Sales by private agency too have always been important. Reference has already been made to the increasing use of green manures in certain tracts, whilst demonstration and propaganda for the better conservation and utilisation of cattle manure and other village refuse is steadily being carried on by the various agricultural departments as part of their regular programme. That the use of ammonium sulphate in particular steadily extended during the last few years, till, owing to the general economic depression, it received a check in the last year under review, is clear from the following figures :—

——	1926	1927	1928	1929	1930
	Tons	Tons	Tons	Tons	Tons
Local production . . .	14,555	13,451	15,082	16,121	16,189
Imports *	2,684	3,915	17,993	24,819	19,851
Exports *	4,304	3,756	10	0	4,850
Approximate consumption . .	12,935	13,610	33,065	40,940	31,190

* Figures for imports and exports refer to the financial year (April to March).

That the use of other artificial manures is extending may also be deduced from the following figures in tons for imports for the last five years :—

—	1926	1927	1928	1929	1930
Nitrate of soda	6,070	7,458	8,840	11,722	4,329
Phosphatic manures . . .	12,591	18,676	25,743	30,867	27,327
Potassic manures . . .	4,509	6,660	6,364	7,486	4,318
Ammonium phosphate types .	3,181	4,939	3,657	3,090	2,874

In 1930-31 there was a definite check in their use by the cultivator. The fall in the price of all agricultural products, especially of cereal products, which has accompanied world production in excess of effective demand, is removing the incentive to the use of purchased fertilizers which the earlier fall in the price of nitrogenous manures provided. Only in rare instances in India has the standard of production of any crop reached a point where a reduction in gross yield, in order to produce more cheaply, is warranted. But with the general fall in agricultural commodity prices, the cultivator's power to purchase fertilizers has been greatly reduced and other means of improving the efficiency of production are being sought.

CHAPTER IX

AGRICULTURAL EDUCATION.

On account of the general financial stringency, agricultural departments have not been able to develop the educational side of their activities, and with the stoppage of any further new recruitment in the departments, fewer students are interested in this branch of education.

1. Agricultural Colleges.

The continued financial trouble was again responsible for the set-back of the scheme for an agricultural institute at Dacca and the hope expressed in the last Review that it might be possible to start the engineering, dairying and animal husbandry sections of the institute was not realized. Nucleus sections of engineering as well as cattle-breeding and dairying were, however, started but the expenditure necessary to complete these sections was not available. Thus there are still few facilities for students who wish to take up agriculture in the eastern half of India.

The COIMBATORE AGRICULTURAL COLLEGE received 365 applications for admission in 1930 as against 303 in 1929. Out of this number the Committee selected 42 and 48 candidates in 1930 and 1929, respectively. Special lectures were delivered to second and third year classes by various research officers in the College. Forty-four students appeared for the B.Sc. (Agriculture) Degree Examination in 1929, and 33 passed, while in 1930, 24 out of 43 passed.

The POONA AGRICULTURAL COLLEGE admitted 82 students for the degree course in 1931 while in 1930 the number of students who received admission was ninety-seven. As in previous years a number of applications were received from outside the province and 10 such candidates were admitted each year. Last year the Bombay University conferred the Degree of B.Ag. on 53 students and this showed a fall of 8 from the previous year's figure. The staff was of the opinion that the candidates for admission to the

College are of too low academic qualifications and suggested some modifications in the degree curriculum of the University. A minor suggestion was made to Government to guarantee at least one provincial post for graduates with first class honours.

The AGRICULTURAL COLLEGE, CAWNPORE, was affiliated to the Agra University in 1930. This necessitated the immediate drawing up of proposals to meet the University requirements which included some additions to the existing staff, the raising of the status of the lecturing staff and important improvements in the material for instruction. A scheme embodying these proposals was framed and submitted to Government, who accepted some of the proposals but desired the curtailment of expenditure and further economy. In 1931 there were 175 students on the College roll as compared to 192 in 1930. Three-hundred-and-one applications were received for admission in 1930 ; of these 195 were for diploma course and 106 for the vernacular course. Forty-six students were admitted to the former and 23 to the latter course. In 1931 there were 151 applications for B.Sc. course, out of which 45 students were admitted. Admission to the vernacular course was stopped. The examination results in both the years were good ; 32 out of 32 passed the Intermediate Examination in 1930 while in 1931 32 out of 36 passed the B.Sc. (Agric.) Examination.

The PUNJAB AGRICULTURAL COLLEGE, LYALLPUR, received 249 applications for admission in the year 1930 as against 412 in 1929. In 1931 the number was reduced to 102, mainly attributable to the fact that there were fewer posts in the Agricultural Department available for graduates than was the case a few years back. Seventy students in 1930 and 50 in 1931 were admitted into the College. Twenty-three students from the Khalsa College gained admission in the 3rd Year Class in 1930 but only 8 from that institution joined in the next year. The University results during two years under review were fairly good, for 34 out of 52 in 1930 and 40 out of 69 in 1931 passed the degree examination. The total number of scholarships for the students of the College were 115 during 1931, out of which 40 were Government scholarships and the remaining 75 were generously donated by District Boards

and private bodies in the province. Two out of three students passed the M.Sc. (Ag.) in 1931.

The NAGPUR AGRICULTURAL COLLEGE, which was affiliated to the Nagpur University in 1925 and held its first degree examination in 1929 in which 5 out of 13 candidates were declared successful, showed much better result in 1930 when out of 19 students 18 passed. The comparatively poor academic results in the past were attributed to the fact that a large percentage of students recruited from the farming communities were not sufficiently educated to be able to cope with the requirement of the degree course. This difficulty was met by stiffening the first year examination and by the introduction of qualifying examinations in the course of the second year, in order to eliminate the unfit students. During the year 1930-31, the 8 students who completed the requirements were allowed to sit in the final examination in which all passed. With the intention of equalizing the numbers in various classes in 1931-32 and not causing the lack of room in the hostel in that year to react against the admittance of a satisfactory number of students, the Principal restricted the number of first year's admissions.

The MANDALAY AGRICULTURAL COLLEGE had 40 students on the roll in 1930-31 as compared to 47 in the previous year. The total number of applications for new entry was 78 in 1930, out of which the Board selected 20 stipendiary and 4 non-stipendiary students. A private Japanese student was also admitted. In the final diploma examination held in March 1930 all the 8 students came out successful, and in the 1931 examination 8 passed out of 9.

The HEBBAL AGRICULTURAL SCHOOL, MYSORE, continued to show an increasing popularity, and the total number of students on the roll increased from 45 in 1928-29 to 71 in 1929-30, and 72 in 1930-31. The school received 158 applications for admission in June 1931 as against 102 in 1930. Two new blocks for accommodating the students in the hostels were built and to allow more adequate practical training a large number of microscopes and 5 new pairs of bullocks were purchased. Of the 24

students who sat for the final examination 12 passed in 1930, of whom 4 passed with distinction. In addition to the regular work of the school, the staff conducted special training classes for Revenue Probationers and Inspectors and these were attended by 24 candidates.

2. Post-Graduate Training in Agriculture.

The IMPERIAL INSTITUTE OF AGRICULTURAL RESEARCH, PUSA and the IMPERIAL INSTITUTE OF ANIMAL HUSBANDRY AND DAIRYING, BANGALORE, continued to offer facilities for post-graduate training in various branches of agriculture. At Pusa three students, one in botany, one in chemistry and one in entomology, completed the two years' post-graduate work in 1930. In the same year, the Entomological Assistant from the Central Provinces and the Assistant Professor of Agriculture in the Punjab Agricultural College completed their one year's training in entomology and botany, respectively. Of the 37 candidates for admission to new session commencing 1st November 1929, six were considered suitable by the selection committee, and accordingly two were admitted for training in mycology, three in botany and one in entomology. An agricultural assistant from the Punjab and a Probationary Assistant Director of Agriculture, Bihar, were admitted to special one-year courses in sugarcane cultivation and general agriculture, respectively. In the same year 4 post-graduate students completed their 15 months' course in animal husbandry and dairying at Bangalore and an equal number was admitted for the new session. In 1930-31, five post-graduate workers completed their two years' work at Pusa, 3 in botany and one each in mycology and chemistry. Thirty new applications were entertained for the session beginning November 1930 ; seven were selected for interview, of whom two were admitted, one in botany and one in mycology. Two other students were accepted for training in botany, and one from Indore Durbar for training in chemistry. One provincial assistant and one deputed by the Jaipur Durbar joined the practical agriculture course. In the same year 5 post-graduate workers completed the 15 months' course in dairying

and 3 joined for the next session. The two-year course for the Indian Dairy Diploma was completed by 24 students.

3. Agricultural Schools.

Besides the two-year course given at several agricultural colleges, there is still a need felt for some sort of vocational agricultural education in various parts of the country and the Governments concerned are doing their utmost to meet the demand. The Taliparamba Agricultural Middle School in MADRAS, which was opened in 1922 for the purpose of providing a Vernacular course of instruction in the principles of agriculture with the intention of sending the boys back to the land as better cultivators, did not function as satisfactorily as it used to during the early years of its existence. In 1929-30 there were 14 boys in the second year class and out of the 17 admitted in the first year only 9 continued to attend till the end of the year. The total strength of the school in the following year was only 12 out of which 8 were in the second year and 4 in the first year class. Such a state of affairs was attributed to the fact that the farmers consider two years to be too long for their boys to be away from their parents who need their presence during the busy agricultural season. The new school at Usilampatti opened in 1929 continued to be under the management of the District Board of Madura. The Agricultural Department lent two officers for teaching and the Government gave a half grant for its maintenance. Even here the attendance was not encouraging; there were 13 students in the second year while out of 5 admitted in the first year 3 left in the course of the year. The 3 farm labourer schools, however, continued with a fair measure of success. There were in all 61 day and 48 night students in 1930-31 as against 57 day and 47 night students in the previous year.

Out of the six agricultural schools in BOMBAY, 3 came under the retrenchment axe and were closed in 1930. Of the rest, the Agricultural School at Devihosur is the most popular and has done a good deal of useful work. In 1930-31 out of 127 applicants for admission 60 boys were allowed to appear at the entrance examination and 23 were selected for admission. In the same year

12 out of 13 boys passed the two years' course. 124 passed students of this school are working on their own farms.

The Bulandshahr Agricultural School in the UNITED PROVINCES played a most useful part in the training of teachers of the Vernacular Middle Schools. There were 31 such teachers in 1931 as compared to 43 in 1930 who received training in subjects such as agriculture, co-operation, hygiene, irrigation, and civics. In the two-year regular course 31 out of 33 students passed the final examination in 1930 while 29 out of 33 got through in 1931. The newly started school at Gorakhpur gained in popularity, and a large percentage of candidates for admission to the school consisted of those who owned sufficient landed property and proposed to take up farming as their profession. An Agricultural and Village Uplift Institute for training the sons of zemindars and cultivators was started in June 1931.

In the CENTRAL PROVINCES, the Powarkhera Agricultural Anglo-Vernacular Middle School, which is the only one of its kind in the province, continued to be popular amongst the cultivators. The total number of students in all the four classes was 110 in 1930 and 115 in 1931. The final class results in both the years under review was very satisfactory: 15 out of 16 passed in 1930 and 13 out of 17 were declared successful in 1931. The prescribed syllabus was followed and the instruction imparted was of a higher standard. The boys took a keen interest in the practical work on the farm and garden which covers an area of $6\frac{1}{2}$ acres. During 1929-30 the gross return of all crops on the farm was Rs. 259 of which vegetables contributed Rs. 173. The year 1930-31 was not particularly favourable but the students were able to produce a fair amount of vegetables for consumption in mess. In addition to the school the Agriculture Department was running two agricultural classes of pre-vocational character at Yeotmal and Buldana. The former has been in existence some two or three years but is not very popular. The latter which was started in 1929 had 14 boys in the first year out of which 12 qualified for promotion to the second year. In the year 1930-31 political activities inter

fered with its regular working and the school remained closed for 3 months.

The Pyinmana Agricultural School in BURMA is financed partly by the American Baptist Mission which is also the controlling body and partly by Government. The object of the School is to train persons coming from the village communities so that they may take up farming as their business and successfully practise it under local conditions. Since the opening of the school in 1923, one-hundred-and-twenty-one students have gained the lower middle certificate by passing the two years' course, and 54 were graduated after completing 4 years. Of the former students 49 are engaged in agriculture proper, 10 in gardening, 14 are school teachers and 8 are in the Agriculture Department. The two farm schools at Hmawbi and Mahlaing worked successfully. The courses given at Hmawbi comprised instruction in determining the different kinds of paddy and rice, the characters of good quality of paddy, the principles of manuring and instruction in horticulture.

Three vernacular schools in MYSORE continued to do useful work and gained in popularity. The respective district boards in which these schools are situated displayed a very marked practical interest and gave special grants to the schools. All these schools were well equipped in the form of land, bullocks and implements for practical instruction and the attempt was being made to bring the teaching to a uniform standard. The three agricultural schools in TRAVANCORE, for imparting instruction in the elements of practical farming to boys who intend to follow agriculture in after-life, did useful work. Twenty-one students were admitted in Alwaye School, out of whom 16 received a stipend of five rupees each per month. They were also allowed to work for wages on the farm attached to the school outside class hours. Kottarakara school had 29 students in training in 1930, out of which 20 received a stipend of Rs. 4 each. At Koni School 52 boys were in attendance of whom 30 were getting a stipend of Rs. 4 each.

4. Rural 'Bias' Schools.

The demand for rural 'bias' schools is being met by opening agricultural classes in various anglo-vernacular schools in different

provinces. In the Punjab, the United Provinces, Bengal and Bombay arrangements are also made to train teachers for teaching this subject in the schools. In BENGAL the first batch of 15 secondary school teachers under training, in connection with the scheme to introduce agricultural classes into secondary schools, completed their two years' course at Dacca School in December 1929. Out of the 15 schools, to which these teachers went back, nine were reported to be doing satisfactory work in 1930-31. The other six were carefully watched and it was decided that in case they do not improve, their grants would be withdrawn. In 1929-30 an officer of the Bengal Agricultural Service was appointed as Inspector of Agricultural Schools who collaborated with the school authorities in the preliminary work of organizing classes, purchasing apparatus and reclaiming and levelling land to be used for practical work. In BOMBAY there were 84 agricultural 'bias' schools in 1929-30 and 81 next year. The training of teachers for these schools was considered to be an important matter in the agricultural 'bias' educational movement and the need was felt of improving the Rural Training School at Narayangaon for training such teachers. A need was also felt for opening another training school in Kanarese Division where the agriculture 'bias' movement was gaining ground. In the UNITED PROVINCES, the agricultural class with small demonstration farms opened at four schools in the Eastern circle and two in the Central Circle were doing useful work. New agricultural classes were opened in 8 more schools in the Central Circle. The Agricultural Department maintained a close touch with these schools and assisted them in preparing cropping schemes and supplied improved seeds and implements. In the PUNJAB there were 143 vernacular middle schools in 1930 where courses in elementary agriculture and nature study were imparted to the students and the number increased to 150 in 1931. Each school is equipped either with a small farm or a school garden, which is run by the Education Department with advice from the Agriculture Department, which in addition provides a one-year vernacular course at the Agricultural College, Lyallpur, for the training of teachers. Twenty-seven senior vernacular certificated

teachers took this course in 1930 and 25 of them were declared successful in the final examination. In 1931 there were 25 students in this class.

5. Short Courses.

During the two years under review short courses in special subjects given at various agricultural institutions and demonstration farms became more popular and the number of those attending increased as compared with the previous years. In the PUNJAB the two vernacular classes of 6 months' duration each were attended by 84 and 32 students, respectively, in 1930 and 39 and 32 students in 1931. The six weeks' blacksmith course for training in the running and maintenance of internal combustion engines and in the maintenance of modern agricultural implements was attended by 13 mechanics in 1930 and by 14 such men in 1931. The two weeks' courses in fruit culture and fruit and vegetable preservation were given twice each year—in July and February of 1929-30 and 1930-31. These courses were extremely popular and only a comparatively small proportion of those applying for admission to them could be accommodated. The rural economy class of one month duration was attended by 23 officers in 1930 and by the same number in 1931.

The two short courses in practical agriculture started at Nagina and Shahjahanpur in 1928 in the UNITED PROVINCES continued to work satisfactorily. All excepting two students of the first batch have started on their own farms. In 1930, four students of Nagina farm were given a grant-in-aid of Rs. 300 each, on condition that they supply to the Department 40 maunds of wheat seed at market rates every year for 5 years. The Shahjahanpur farm class did not admit any student in 1931, while at Nagina, out of thirteen students on the roll, there remained only four who appeared in the final examination. A short course of instruction in sugarcane cultivation of 10 days' duration was started in 1929 at Shahjahanpur farm for officers of the Irrigation Department nominated by the Government.

In BOMBAY classes were organized for training in irrigated crops, horticulture and land improvement. The class on irrigated crops was attended by cultivators as well as the subordinate staff of the Irrigation Department. A horticulture class organized at Akola was attended by 36 students and another at Jambul was attended by 53 cultivators. A short tractor class of two-and-a-half months' duration was opened to train students in the management of different tractors. For the course Messrs. Volkart Bros. supplied four tractors of different make and Messrs. Burma-Shell Oil Storage and Distributing Company were kind enough to find all the oil and fuel. Seventeen students joined the class but only 9 appeared in the examination of whom 7 passed.

In BURMA short courses of a few weeks' duration were held at various times of the year on the experimental farms for adult cultivators who cannot afford to be away from their holdings for longer periods. The cultivators who came to these farms were brought into personal touch with the work on the farms and friendly relations were established between them and the staff. A short course in plant-breeding and experimental plot technique organized for provincial and senior agricultural assistants in 1929-30 was attended by 10 members of the district staff.

In the CENTRAL PROVINCES a nine months' class for training teachers to give instruction in elementary agriculture, on the lines followed in some of the Vernacular and Anglo-Vernacular Middle Schools in the Punjab, was opened in 1931 with a roll of eleven. It was thought that these men would be useful in rural "bias" schools which the Department will start when funds permit.

6. Adult Education.

Facilities were provided for adult education in several provinces. In the Eastern and Central Circles of the UNITED PROVINCES there were 40 co-operative adult education societies in 1929-30, and this number increased to 47 in 1930-31. The societies in Benares district got their teachers trained in the rural workers' training class opened at Benares, and those at Partabgarh were

provided with village guides trained at Partabgarh. Several meetings were held and various subjects connected with agricultural improvements were discussed. Lectures were delivered on proper methods of preservation of farmyard manure, advantages of improved seeds, deep ploughing, labour-saving machines and implements, artificial manures, and advantages of green-manuring and other agricultural subjects.

CHAPTER X

THE CO-OPERATIVE MOVEMENT AS AFFECTING AGRICULTURE.

The co-operative movement, which started about 25 years ago, progressed remarkably within this short period and the number of societies in the whole country increased from 1,500 in 1908-09 to 104,187 in 1929-30. The majority of these are concerned with one or the other phase of agriculture, especially with the credit movement amongst the cultivators. The total number of agricultural societies in 1929-30 and 1930-31 was 77,550 and 78,633, respectively, out of which 74,145 and 73,600 were purely for credit purposes. Though the previous yearly rate of increase as regards the number of societies and their membership figures have not been maintained during the two years under review, still the movement shows an all-round improvement with few weak spots here and there. The major cause of slowing down the rate of progress is the decline of prices of agricultural commodities and the disturbed credit facilities throughout the world to an extent almost without precedent. In spite of the policy of caution, which has been adopted in all provinces, the amount of outstanding dues has considerably increased. The rapidity of the movement in previous years brought into existence some weak societies with unscrupulous members, with the result that a few influential members monopolised the bulk of the loans and proved to be the worst defaulters. Lack of understanding of the principles of co-operation was another cause of bringing certain societies to grief. To check the further spread of these evils and to eradicate or at any rate to eliminate the existing weaknesses, the co-operative departments directed their energies towards the consolidation of the movement and the spread of sound ideas.

On the other hand, the new policy adopted by the provincial governments has elevated the general trend of the movement. In Bombay new registration is confined only to societies with share

capital and the old societies have also been advised to adopt this system. Bengal has suggested the discontinuance of the defective policy of investing short-term capital in long-term loan. By establishing a Central Land Mortgage Bank, Madras has given a great impetus to the primary mortgage banks. The general policy adopted by all provinces of confining the movement to productive channels and weeding out bad societies has met the need in the present depression.

The development of the agricultural non-credit societies, in particular, has been very rapid during these years, and the range of their function has been greatly widened. They include societies for the general sale of agricultural produce, for production and sale of implements and manures, for furtherance of irrigation projects, for consolidation of holdings, for maintenance of construction of roads and for assisting agricultural departments in spreading knowledge of improved methods of cultivation.

Madras.—From 12,947 in 1928-29 the number of agricultural societies of all types increased by 19, bringing the total to 12,967 in 1930-31. These societies distributed Rs. 163·5 lakhs to their members as loans of which about 99 per cent. was for productive purposes. Another noticeable feature was the preponderance of loans for short-term purposes; the ratio between the short-term and the long-term being 62 : 38.

The number of agricultural credit societies increased from 12,382 in 1928-29 to 12,540 in the next year but fell to 12,310 in the succeeding year. The membership figures, however, showed a continuous increase and now stand at 676 thousand. The total divisible profit earned by the credit societies in 1929-30 and 1930-31 was Rs. 11·5 and Rs. 8·05 lakhs, respectively.

The Government sanctioned a scheme for the establishment of a Central Land Mortgage Bank composing of individual non-borrowing members and primary land mortgage banks affiliated to it. The bank was registered in December 1929 and was empowered to issue interest-bearing debentures on the security of mortgages executed in favour of primary banks. For the safeguard of the investor government undertook to guarantee the interest not ex-

ceeding 6 per cent. for a period of 20 years on all debentures issued within the first 5 years up to a limit of 50 lakhs of rupees. The unsettled condition of the money market, however, affected the operation of the bank which experienced considerable difficulty in selling its debentures. As there was no prospect of a steady flow of funds, the organization of new banks was suspended and postponed till the financial conditions improve. On 1st June, 1931, the bank had 166 individuals and 37 primary land mortgage banks as members; its paid-up share capital amounted to Rs. 99·5 thousand. Government help to the bank has been in the form of a free grant of Rs. 14,000 to meet the working expenses and a loan of Rs. 15,000 for establishment charges. It has also remitted the duty charged under the Indian Stamp Act on deeds of transfer in respect of the debentures of the bank. Last year the bank issued debentures for Rs. 10 lakhs, bearing interest of 6½ per cent. per annum. The 37 primary land mortgage banks had 5,128 members with a working capital of Rs. 17 lakhs. Fifteen of these banks worked at a profit of Rs. 18,372, and the remaining 22 incurred a loss of Rs. 11 thousand.

Out of 128 PURCHASE AND SALE SOCIETIES in the beginning of the year 1931, there only remained 108 at the end of the year. Sixty-six of them were loan and sale societies which, in spite of a constant effort, did not develop as they were expected and thus some of them had to be liquidated. At the beginning of the last year under review these societies had a stock of goods worth Rs. 39 thousand and during the year they purchased goods to the value of Rs. 456 thousand, and out of this, stock worth Rs. 465 thousand was sold to the members. The 13 irrigation societies undertook the work of silt digging of irrigation channels. Water was supplied to irrigate 2,261 acres of land, the cost of which was paid by the members. These societies also brought 2,943 acres of new land under cultivation.

The LAND RECLAMATION SOCIETIES, which increased from 10 to 12 in the two years, did fairly good work and reclaimed 1,664 acres of silted land. The number of agricultural demonstration societies, however, remained constant but out of the total 17 only 3 can be

said to have done useful work. These 3 societies cultivated 83 acres of paddy out of which 73 acres were under improved methods of cultivation and the rest were under ordinary methods generally used by the farmers. The net gain per acre between the old and the improved methods ranged up to Rs. 27 in 1929-30. These societies have also undertaken the work of supplying improved seeds, manures, etc., to their members as well as to non-members, and in the last year they did business worth Rs. 45 thousand with the members and more than a lakh with non-members.

Bombay.—The process of consolidation and elimination of weak co-operative societies was continued during the last two years and as a result of this vigorous step a large number of bad societies and improvident members have been eliminated. The policy has already begun to show its results in a better standard of management, and the figures show an all-round progress. The number of agricultural societies rose from 4,568 in 1928-29 to 4,889 in 1930-31 ; similarly membership increased from 338 to 339 thousand, working capital from Rs. 369 to 449 lakhs and reserve fund from Rs. 50 lakhs to Rs. 66 lakhs.

AGRICULTURAL CREDIT SOCIETIES.—The progress in this particular field of agricultural co-operation has been satisfactory. The number of these societies increased from 4,317 to 4,650, membership increased by 5,715 and the working capital by Rs. 75 lakhs, in two years ending with 1930-31. In the same period the reserve fund showed an increment of about Rs. 15 lakhs. There was, however, a fall of about 3 lakhs in the members' deposits. This was partly due to the recent policy of confining new registration to societies with share capital and advising the old societies to adopt the share system bye-law, and partly to the adverse economic conditions which forced the agriculturists to draw upon this source of their savings, for meeting household and agricultural needs.

The standard of efficiency in the working of societies is gradually rising and this is mainly due to the activity of supervising unions. The accounts are generally kept up-to-date and there are now fewer chances of mismanagement due to ignorance of rules and bye-laws.

The condition of 3 CANAL SOCIETIES is serious. The reason is that the old loans are overdue and these have been further added by fresh loans in the hope that the conditions would improve and that the sugarcane growing would become a paying proposition. This has not come true and the price of *gur* and other cash crops like cotton and ground-nut having fallen all-round, all the growers have lost considerably. Three LAND MORTGAGE BANKS, on the other hand, have done good business, but could not proceed with their programme on account of the lack of funds. The application sanctioned for advancement on loan exceeded the money which could be lent and the position at present is that Rs. 3·61 lakhs are immediately needed for meeting the sanctioned and the pending loan applications.

AGRICULTURAL NON-CREDIT SOCIETIES.—On the whole the working of the existing societies was quite satisfactory but no further development occurred due to inability to secure efficient personnel for management.

Societies for the sale of agricultural produce, especially cotton, constitute the most important of agricultural non-credit societies. During 1930-31 these handled 4,00,243 maunds of cotton and realised Rs. 37 lakhs. There is, however, a great danger to which sale societies are particularly prone at the moment, *viz.*, that the buyers, due to the existing trade depression, are not meeting their obligations. The boycott movement also proved to be a serious problem in Gujarat and Belgaum Divisions.

There are at present 6 PURCHASE AND SALE UNIONS in the Presidency. Out of these, the West Khandesh District Purchase and Sales Union continues to flourish. Besides arranging to sell cotton and ground-nut, worth Rs. 2,31,242, and Rs. 39,640 respectively, the Union arranged for ginning of *Kapas* (seed cotton) worth Rs. 82,213 and for the supply of seed and other agricultural requisites worth Rs. 138,509.

Of the eleven MANURE SOCIETIES only six did a fairly large amount of business and sold 386 thousand lbs. of manure and earned a profit of Rs. 1,145. There is very little scope of developing

societies of this type, for the same work is being taken up by purchase and sales unions.

Out of the MACHINERY AND IMPLEMENT SOCIETIES only one has met with a fair amount of success. The society installed a power-crusher, run by an oil-engine at Nanda, and earned Rs. 520 as profit by renting it to the agriculturists. Other implement hire societies have not proved successful, probably because the ploughs they stock cost so little that it pays members to buy rather than to hire them from the society.

Of the three DAM CONSTRUCTION SOCIETIES one was cancelled. Out of other two, Mutta Dam Construction Society has proved very successful. It puts a temporary dam across the river every year to prevent the sea water coming in and to raise the level of river water for irrigation purposes. This scheme has enabled members to get water for irrigating garden lands and for sugarcane.

There are 14 FENCING SOCIETIES. The Kunnur Fencing Society constructed a five-and-a-half miles of wire fence at the cost of Rs. 12,000 which has encouraged cultivators to go in for sugarcane. The other societies in this class are working fairly well.

TALUKA DEVELOPMENT ASSOCIATIONS, of which there are 81, popularize the use of improved seeds, manures and implements by holding demonstrations and agricultural shows. All of them are financially sound and doing good propaganda work. In some places they are running their own fruit farms from which they supply seedlings, etc., to the cultivators.

Punjab.—The number of agricultural societies increased from 16,473 to 17,541, the membership from 504,907 to 569,296 and the working capital from Rs. 731 lakhs to Rs. 849 lakhs during two years under review. Of these 16,309 are pure agricultural credit societies. The activities of the department were centralized towards the expansion of the societies that already existed and, as a result, 30 thousand new members joined the already existing societies in the last year. Nearly Rs. 356 lakhs were advanced as loan to the members and if we add to this the previous unpaid debt, the outstanding loans at the end of 1930-31 amounted to Rs. 718 lakhs. This gives an average debt per member, whether indebted or not,

of Rs. 144 which is little more than the previous year. As in the previous years, purchase of cattle, revenue and payment of old debts are the most important items for which the loans were granted.

LAND MORTGAGE BANKS, which are 12 in number, show very little profit for they have been badly hit by the collapse of prices of the agricultural commodities. At a time, when agricultural enterprises hardly show any return and the repayments of credit societies are correspondingly difficult to get, it is hard to expect any substantial gain in the dealings of Mortgage Banks. Accordingly, for this reason and also as a measure of economy whereby to help Government, the Registrar surrendered the whole of Rs. 8 lakhs that had been budgetted for as available for granting loans to Mortgage Banks through the Provincial Bank. At a Conference held at Lyallpur to consider the situation as regards the business of these banks it was decided that in view of the present conditions of zemindars, the instalments due from borrowers should be reduced by 50 per cent; secondly that in future loans should be limited to 5 times the land revenue and lastly that loans for redemption of land and payment of old debt should cease to be given.

Consolidation of holdings continues to be one of the main activities of the Co-operative Department. Two-hundred-and-fifty-five new societies were registered during the last two years, which bring the grand total of the CONSOLIDATION OF HOLDING SOCIETIES to 795. In the year 1930-31 these societies consolidated 72,821 acres which were split up in 118 thousand blocks; the number was reduced to 21,627 blocks. The total cost to the Government of consolidation this year was Rs. 1·26 lakhs, which works out to Rs. 1·12 per acre. As all prospects of enhancing assessment in the future seem to have vanished, it can be said that Government will reap no material benefit from its expenditure. In spite of all the success, the difficulties of convincing the cultivators of the merits of this movement continue. There is still but little to indicate, that if Government were compelled to retrench the consolidation staff, which is only temporary, any more land would be consolidated at all.

There are at present 3 UNIONS and 18 SOCIETIES FOR AGRICULTURAL PURCHSE AND SALE. Most of them are in Criminal Tribes Settlements, situated in the Multan Circle. Only one of these seems to have done good business. It sold 920 maunds of improved seeds and a full wagon of salt.

CO-OPERATIVE COMMISSION SHOPS for the sale of agricultural produce numbered 25 with 3,595 individual members and 1,280 society members. The value of produce sold went down from Rs. 47 lakhs in 1928-29 to Rs. 30 lakhs in 1930-31 though the amount of produce handled actually increased during this period. Regarding business there was no difficulty during the year but due to fear of making the shop unpopular or from sheer inability to say no, too much credit was expended which resulted in more than Rs. 5,000 of bad debts. A few troubles on a much smaller scale have been caused by advancing money on the security of produce, and not demanding more security when the price of the produce fell or selling it in time. For such faults it is the management who are to be blamed.

Of the thrift societies the most important group is the CROP FAILURE RELIEF SOCIETIES which number 62—an increase of 47 in the last 3 years. These have accumulated Rs. 4,896 in contributions, which has been swelled to Rs. 5,309 by interest. Besides these there are 11 LAND REVENUE REDEMPTION SOCIETIES and three FODDER STORAGE SOCIETIES in Hissar.

Assam.—In the last two years the number of agricultural co-operative societies increased from 1,234 to 1,304, membership from 53 thousand to 55 thousand and the working capital from Rs. 26 lakhs to Rs. 30 lakhs. Though there is an increase in the number of societies yet a considerable number are not in a flourishing condition. This is reported to be mainly due to defective organization, insufficient and inefficient supervision, and the absence of sufficient co-ordination between the Central Bank and their affiliated societies. Due to the large outstanding debts the policy of giving new loans was contracted. The Agricultural Department which used to sell seeds and implements to the agriculturists through the co-operative societies on credit, adopted the policy of cash sales and thus sold goods worth Rs. 1,471 in 1930-31 as against Rs. 21,381 (on credit)

in the year previous. That shows how little cash there is with the farmers. The Co-operative Department devoted time and attention towards consolidation rather than to expansion. The registration of several new societies from localities where there was a persistent demand had to be refused for want of an adequate staff for supervision. Out of the five LAND MORTGAGE BANKS, all but one continue to make steady progress.

Central Provinces and Berar.—In the two years under review, the agricultural co-operative movement showed a definite advance in the first year, for the number of credit societies increased from 3,787 to 3,950, membership from 57 thousand to 59 thousand and the working capital rose from Rs. 162 lakhs to Rs. 171 lakhs. While in the second year there was a marked set back ; the number of these societies fell from 3,950 to 3,915, membership from 59 thousand to 58 thousand and the working capital from Rs. 171 lakhs to Rs. 167 lakhs. This was due to the fall of agricultural prices which made it harder for the members to pay back their loans which were advanced on the prices prevailing in the past. Under such conditions the work of reorganising was pushed ahead which resulted in the elimination of weak societies. 196 societies were cancelled last year and though 161 new societies were registered, there was a net loss of 35 in total.

The number of agricultural non-credit societies, however, increased from 21 to 42, membership from 1,865 to 2,289 and the working capital from Rs. 1·4 lakhs to about Rs. 3 lakhs. The 8 co-operative commission shops which were organized to sell the produce of their members in the market did good work during the two years.

Delhi.—Unfavourable agricultural conditions and fall in the prices of agricultural commodities have concentrated efforts on the maintenance of the movement, avoiding expansion in agricultural credit. In the course of 12 years agricultural credit has touched 165 villages, representing 54 per cent. of the total number in the province. The number of agricultural societies decreased from 236 to 221 and there was a corresponding small decrease in the membership from 5,511 to 5,423, but there was a slight increase in

the working capital which went up from Rs. 7·4 lakhs to 8·7 lakhs. The old societies, which have completed their tenth year, have introduced a compulsory deposit system for a period of 5 years.

Though there is no society for the women alone, there are a few widows in the village credit societies who are members in place of their deceased husbands. They are more punctual and scrupulous repayers than the male members.

The consolidation of holdings was taken up in one village where 905 acres distributed in 3,444 fields were consolidated into 376 blocks. The average area per field has been increased from 0·26 to 2·4 acres, *i.e.*, nearly ten times.

Bengal.—The two years under review were by no means prosperous ones, for the adverse economic conditions imposed on the movement a much severer strain than it had ever had to face. This rendered necessary the adoption of a policy of caution in matters of expansion and most of the energies were directed towards consolidation of the movement. During 1929-30, the position of co-operative societies was examined by the Bengal Provincial Banking Enquiry Committee which pointed out 3 main defects in the movement namely, the illiteracy of members and their ignorance of co-operative principles, heterogeneous membership, and delay in obtaining loans by primary societies. Another defect of the movement brought to light was the failure on the part of many Central Banks and most credit societies to distinguish between long and short-term credit and the practice hitherto followed by many of these institutions of investing short-term capital in long-term loans. In spite of this the number of agricultural societies increased from 18,009 to 21,506, membership from 478 thousand to 536 thousand and the working capital from Rs. 470 lakhs to Rs. 561 lakhs during the two years ending with 1930-31.

AGRICULTURAL CREDIT SOCIETIES constitute the bulk of registered co-operative societies and comprise 85 per cent. of the total number. The actual number of societies including Grain Banks rose from 16,930 to 20,172, membership from 408,980 to 476,962 and the working capital from Rs. 421 lakhs to Rs. 538 lakhs. During the years under review there was a big drop in recoveries of loans by

agricultural credit societies, and this was due to the collapse in the prices of agricultural commodities. Of the Grain Banks only a few are doing useful work. Others are either in a moribund condition or are existing nominally.

The number of AGRICULTURAL PURCHASE AND SALE SOCIETIES declined from 100 in 1928-29 to 95 in 1930-31. The membership also decreased from 28,982 to 12,935 and the working capital from Rs. 37 lakhs to Rs. 7 lakhs during the same period. The decrease was mainly due to the closing down of the jute sale societies which failed and became insolvent. The paddy sale societies, though affected by the general trade depression, managed to work well on the whole and some of them did quite good business during this period.

The number of irrigation and drainage societies rose in two years from 773 to 929 and their membership from 20,133 to 23,747. As many as 915 of these societies are in Burdwan division where they are generally doing useful work. There is still a great scope for the promotion of these societies in the same division, particularly in the undulating districts where the annual rainfall is comparatively small and is not well distributed.

The other types of societies worth mentioning are the CO-OPERATIVE AGRICULTURAL ASSOCIATIONS which are 38 in number and PRODUCTION AND SALE SOCIETIES the bulk of which are really milk societies. In spite of the drop in prices the milk societies continue to work at a profit and it is gratifying to know that a part of their profit is devoted to local works of public utility, such as the establishment of schools and the sinking of tube-wells within their areas. Co-operative activities have also been extended to silk manufactures. The Bengal Co-operative Silk Union, which was established in 1927 to organize workers in sericultural industry and silk manufacture and generally to pursue a policy for the development of the industry, is financing 32 affiliated silk societies of mixed type with 558 rearers, reelers or weavers as members. The Union is a co-operative body and is the good result of collaboration between Mr. Peddie, the Collector of Malda, the Department of Co-operative Credit and the Sericultural Section of the Department of Agri-

culture. The object of the Union is to organize rearers to pool their produce to be worked up and marketed as an aggregate.

North-West Frontier Province.—Progress in the field of agricultural co-operation is considered to be adequate and further expansion is being undertaken with caution. The number of AGRICULTURAL CREDIT SOCIETIES increased from 89 to 239, membership from 2,500 to 5,923 and the working capital from Rs. 2·1 lakhs to Rs. 5·39 lakhs. The main efforts of the co-operative staff was to consolidate and improve the existing societies which, in spite of the political unrest and economic disturbance, worked well during the period under review. Great attention was also paid towards the training of the members and this was directly imparted by the Inspectors themselves. One great feature of the movement is that women are joining the credit societies.

The total amount of loans at the end of the year was Rs. 5·15 lakhs. The maximum credit limit of the members was reduced and the loans were confined to productive purposes only.

The work of consolidation of holdings was undertaken in 4 villages ; and the number of blocks were reduced from 1,652 to 290.

United Provinces. —Some little progress is noticeable in the development of non-credit agricultural societies though there has been a marked and steady deterioration in the working of the credit side of the agricultural co-operative movement. The total number of agricultural credit societies decreased from 5,390 in 1928-29 to 5,044 in the next year and to 5,010 in 1930-31 ; consequently the membership figures fell from 1·27 lakh to 1·13 lakh in these two years. The decline would have been greater but for the fact that 350 societies which were on the verge of liquidation were reorganized and in addition 180 new societies were registered in the last year. Though the economic conditions all round were not favourable, yet the financial condition of societies continued to show improvement. Their reserve fund increased from Rs. 22·9 lakhs in 1929-30 to 24·7 lakhs in 1930-31 and their owned capital is now Rs. 50·5 lakhs or nearly half the total working capital. The profits made during the year went up from Rs. 6·5 to 6·9 lakhs and losses decreased from Rs. 50 to 12 thousand. There are 2,595 societies

now of over 10 years' standing and out of this number nearly 11 hundred of them were able to distribute dividends to the extent of Rs. 41,000. The loan outstanding with members decreased from Rs. 83·7 to Rs. 82·5 lakhs in the last two years, while the overdues went up from Rs. 32·3 to 53·7 lakhs.

SUPPLY AND SALE SOCIETIES.—The Sugarcane Sale Union at Ghugli, in the Gorakpur district, was able to expand its business from 53,000 to nearly one lakh of maunds of cane without increasing the number of its member societies which is still 16. There is still a considerable scope for expansion. The ghee sale societies had a very bad time due to the fluctuations in the price of ghee, yet out of 11 such societies only two worked at a loss. The total amount of ghee handled by these societies was about 250 maunds. Out of the 5 agricultural supply societies in 1929-30 there only remain 3 and none of them is working at a profit. The field of co-operation has been extended to the poultry business and 4 societies were registered for selling poultry products.

Bihar and Orissa.—The number of agricultural co-operative societies increased from 8,715 to 8,799 in the two years under review, though the yearly figures show that there was an increase of 102 in the first year and a decrease of 18 in the second. The membership figures showed a decrease of 8,839 in 1929-30 followed by another decrease of 1,437 in the next year. The working capital now stands at Rs. 236 lakhs which again shows a fall of Rs. 5½ lakhs from the last year's figures. On account of the policy of caution followed by the banks on one hand and the reluctance on the part of the societies themselves on the other, the total amount of loan advanced to the members showed a heavy fall, amounting to Rs. 16·3 lakhs as against Rs. 33·6 lakhs in 1929-30 and Rs. 64·5 lakhs in the previous year.

Primary credit societies numbering 8,718 formed the great bulk of the total number of societies in the province with 213,137 members and working capital of Rs. 231·9 lakhs. The monopolisation of the bulk of the loans by a small number of rich and influential members was an evil which received serious attention. Such people become the members of the managing committees and are

often directors of the banks. They generally are the worst defaulters but in the long run it is the entire membership which suffers the whole loss due to unlimited liability of the society's debt. An investigation into the matter showed that 40 per cent. of the loans are advanced to 25 per cent. of the total membership.

The most popular of all the agricultural non-credit societies are the GRAIN GOLAS which are 68 in number with a membership of 20,552 and a working capital of Rs. 3·7 lakhs. The LAND IMPROVEMENT SOCIETIES, which come next in importance, lent to their members Rs. 24 thousand of which Rs. 13·6 thousand were spent on reclamation of waste land, Rs. 4,576 in sinking wells and the rest in constructions of bundhs and other similar purposes. There were also three IRRIGATION SOCIETIES, but on the whole their work was not satisfactory and all of them resulted in a net loss. The 3 PURCHASE AND SALE SOCIETIES were also in a very bad financial condition and need to be wound up in the near future.

Some activities of the central banks in the direction of agricultural and land improvement need special mention. Some of these banks took part in the distribution of improved seeds and the progress was especially marked in the cultivation of cotton, wheat, sugarcane, barley and certain other crops, and some others distributed manure and, in co-operation with the Agricultural Department, carried out demonstrations of improved agricultural implements. Lack of funds restricted such activities but the progress, though slow, is very marked in some places, particularly in Orissa.

Mysore.—The number of RURAL CO-OPERATIVE SOCIETIES rose from 140 in 1928-29 to 177 in 1930-31. Their activities mainly consist in stocking of implements, seeds and manures for sale to their members, and in 1929-30 they did business worth Rs. 60 thousand. Four of these societies took over practically the whole of the sales and distribution work in their respective taluks from the Department of Agriculture and were responsible for the supply of implements, seeds and manure to a total value of nearly Rs. 30 thousand. The Co-operative Society of Maradihelly ginned and marketed the crops of the village in a pure condition.

The Agricultural and Experimental Union did very valuable work in the way of testing improvements recommended by the Department of Agriculture. Valuable results were obtained from the testing of Satara ploughs, improved varieties of seeds and new chemical manures on various crops. The Union employed at their own cost two special fieldmen for a period of 4 months to help the local offices in the work of collecting results during harvest.

VILLAGE PANCHAYATS have been brought into the scheme of agricultural development for the purposes of propaganda and demonstration work. In 1930-31 there were 716 such organizations and these mostly confined their operations to the purchase of improved implements for demonstration in the villages.

2. Co-operative Cotton Sale Societies.

In spite of the hard times due to the trade depression on one hand and the boycott movement on the other, the co-operative cotton sale societies did a fair amount of business. The number of these societies in BOMBAY was 24, out of which 7 were in the southern division, one in Khandesh, one in Belgaum and the rest in northern division. In the southern division Hubli and Gadag societies, as in previous years, continued to be the most important ones. The Gadag society increased its reserved area from 14,000 to 23,652 acres and sold about 85,390 mds. of cotton during 1931. The society, however, lost in the seed business to the extent of Rs. 13,187. The Hubli sales society sold 54,766 mds. of cotton but lost Rs. 9,325 in the seed business. The loss in both the cases was due to wrong estimating and over-stocking. These two societies, however, are the best of their kind throughout India and have co-operated with the Agriculture Department in the distribution of improved cotton seed throughout the division. The societies in the northern division did fairly good business. The Bail-Hongal cotton sale society in Belgaum division was boycotted by the local dealers and all efforts to lift the boycott failed with the result that the cotton had to be taken to a ginning factory 20 miles off and then sent to Bombay for sale. The Pachora cotton sale society in Khandesh sold 16,140 mds. of cotton for Rs. 59,212.

In the MADRAS PRESIDENCY the Deputy Director of Agriculture appointed under the Registrar of Co-operative Societies for the development of cotton, loan and sale societies in the principal cotton areas, took charge in March 1931. There are at present five societies in the Presidency dealing in cotton. They are at Tiruppur, Trichengode, Koilpatti, Nandyal and Bellary. Besides these, there are a number of registered and unregistered Seed Societies and Unions who obtain seed of improved types of cotton from the Agricultural Department, grow and dispose of the produce under departmental control, the Department buying back the seed at a premium.

In the PUNJAB there were 25 co-operative commission shops which sold produce of their members worth 30 lakhs of rupees. This includes all kinds of stuff but cotton and wheat are the most important. The Okara Sale Society continues to function with success and sold 279,611 mds. of produce worth Rs. 9·29 lakhs of which cotton was the most important item.

CHAPTER XI

PUBLICATIONS OF THE AGRICULTURAL DEPARTMENTS.

A list of agricultural publications issued during the two years under review is given in Appendix XIII. The change which took place towards the end of the period in the names and editorship of the publications issued by the Imperial Department of Agriculture has been recorded in Chapter I. Publications of the Imperial Department of Agriculture during the two years numbered 34 memoirs (15 botanical, 16 chemical, 2 entomological and 1 bacteriological) and 11 bulletins.

A reference to the contents of the journals and memoirs will show the wide range of subjects covered and their practical application. Many of the publications deal with completed investigations the results of which have been discussed elsewhere in this Review. As usual most of the scientific work done in the provinces was published in these series.

Provincial and State Publications.—The Department of Agriculture, Madras, issued 20 leaflets and 16 other publications during the period, many of these being also issued in the important vernaculars of the Presidency. The "Villagers' Calendar" continued to be printed in English and the principal vernaculars, the size of the edition running to nearly a lakh every year. The publication of the year-book was discontinued from 1929, and the monthly digests were converted into quarterlies from the same year and were issued in English as well as in the main vernaculars.

The Bombay Department of Agriculture issued 7 bulletins and 29 popular leaflets, the latter also in most cases in the appropriate vernaculars.

In Bengal 23 leaflets, embodying the practical recommendations of the Department, were published during the years under report.

In the United Provinces, the two departmental vernacular agricultural journals, the "Mufid-ul-Mazarin" and "Kisan Upkark" continued to be issued regularly, the circulation amounting

to nearly 1,500 in each case. The departmental bulletins issued during the period numbered 24.

The Punjab Agricultural Department continued to publish the "Seasonal Notes" half yearly and also issued 37 leaflets during the period. The Punjab Board of Economic Inquiry published two important publications, *viz.*, (1) "Farm Accounts in the Punjab, 1928-29 (being the fifth year's accounts of certain farms with new sections with special reference to Well Irrigation in the Punjab)", by H. R. Stewart and S. Kartar Singh, and (2) "Report on a Preliminary Survey of the Milk Supply of Lyallpur in 1927", by S. Labh Singh.

The Department of Agriculture, Burma, continued to publish the "Agricultural Calendar", nearly 8,000 copies being printed and distributed every year. In addition, two "Cultivators' Leaflets", 4 bulletins and 2 "Agricultural Surveys" were also issued during the period.

The Bihar and Orissa Agricultural Department issued 12 leaflets and bulletins containing the practical recommendations of the Department.

In Assam the Department of Agriculture issued 8 bulletins and leaflets.

In Mysore the Department published an "Agricultural Calendar" in English as well as in Kannada each year and in addition 9 bulletins and in Travancore the Agricultural Department issued two leaflets.

CHAPTER XII

RECEIPTS AND EXPENDITURE OF THE AGRICULTURAL AND VETERINARY DEPARTMENTS.

The following tabular statements show the expenditure and receipts of the Agricultural and Veterinary Departments of the Imperial and Provincial Governments for the three years 1928-29 to 1930-31.

Agriculture.

Name.	1928-29.		1929-30.		1930-31.	
	Expenditure.	Receipts.	Expenditure.	Receipts.	Expenditure.	Receipts.
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
Punjab	27,56,109	7,09,133	29,24,754	9,56,531	26,74,386	6,92,087
United Provinces	25,22,714	4,45,921	24,23,361	4,93,447	23,75,295	4,55,280
Madras	18,35,359	3,04,727	19,48,385	2,64,224	20,29,559	2,28,196
Bombay : Presidency proper	18,28,300	2,59,700	18,63,860	2,85,750	14,35,905	2,18,211
Sind					3,48,991	44,205
Imperial Department of Agriculture	15,54,813	4,39,959	15,71,884	5,46,039	15,50,062	4,79,113
Central Provinces	11,95,679	3,82,130	11,78,853	3,71,245	11,29,025	3,54,119
Bengal	11,21,619	1,60,411	10,67,713	1,70 918	10,76,453	1,14,932
Burma	9,40,958	1,15,856	10,53,834	1,29,092	9,76,659	95,069
Bihar and Orissa	5,84,943	1,67,216	7,45,087	1,56,646	6,86,937	1,26,789
Assam	3,84,417	82,587	4,57,841	88,294	4,60,441	82,235
North-West Frontier Province	69,698	24,676	69,976	24,884	79,996	26,868
Baluchistan	19,262	10,836	19,814	12,859	17,763	10,264
	1,48,13,871	31,03,152	1,53,46,262	34,99,879	1,48,41,472	29,27,368

Veterinary.

Name.	1928-29.		1929-30.		1930-31.	
	Expenditure.	Receipts.	Expenditure.	Receipts.	Expenditure.	Receipts.
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
Punjab*	13,92,167	2,09,720	14,09,912	2,27,562	12,46,893	1,80,139
Madras	10,32,261	26,730	11,82,754	32,998	11,67,948	35,294
Imperial Institute of Veterinary Research, Muktesar, and the Izatnagar Sub-Station.	7,53,656	14,90,996	7,77,321	15,60,237	8,29,409	12,00,381
Burma	6,41,996	1,383	6,39,000	635	6,38,000	1,070
United Provinces	4,55,281	98,451	5,39,025	1,36,195	5,32,852	1,11,146
Bombay	5,17,634	10,974	4,54,332	11,561	4,76,696	8,789
Central Provinces	4,38,743	1,386	4,47,930	2,357	4,25,880	1,637
Bengal	5,44,547	1,73,348	4,34,963	1,29,585	4,10,455	1,03,835
Bihar and Orissa	4,30,260	1,04,151	4,19,251	1,26,553	4,42,272	1,21,966
Assam	1,32,298	38,361	2,04,305	1,036	1,81,667	1,098
North-West Frontier Province	65,730	..	80,937	..	78,869	4,686
Baluchistan	77,635	3	74,269	328	74,080	344
TOTAL	64,82,208	21,55,503	66,63,999	22,29,097	65,05,021	17,71,385

* Excluding Breeding Operations.

As foreseen in the last Review, shortage of money checked the steady advance that had been going on for the last twenty-five years, rendered any large expansion impossible and in some provinces led to the curtailment of existing forms of assistance to the agriculturist. However, in spite of this handicap, the essential services were maintained in an efficient condition. The present agricultural depression caused by the world-wide collapse in the prices of almost all primary commodities calls for increased efficiency in production and this implies undiminished grants for investigation and research. Perhaps the point cannot be better stated than in an extract from the proceedings of the Imperial Conference of 1930 :—

" It is important that investigations, once begun, should not be subject to unreasonable interruptions because of financial stringency. There is a real danger in times of financial stress that governments may be tempted to economise in expenditure on scientific services on the ground that the need for them is less urgent than for other forms of expenditure, and that research can well be

put on one side until prosperous conditions return. In the opinion of the Research Committee, the need for the conduct of scientific enquiries, and the application of the knowledge gained thereby, is more urgent when industries are depressed than when they are flourishing. Research cannot be expected to yield fruitful results if it is pursued in fits and starts. The Committee have embodied these views in the following resolution :—

"The Research Committee of the Imperial Conference, being convinced that progress will in future be dependent to an increasing extent upon the growth and application of scientific knowledge, desire to direct the attention of the various Governments of the British Commonwealth of Nations to the importance of making adequate provision from State funds for the steady pursuit of scientific research into the various problems affecting the material well-being of mankind. They also desire strongly to urge their view that the severe economic depression from which the British Empire, in common with the rest of the world, is now suffering, should be regarded as a reason not for the curtailment but for an expansion of expenditure on research. The greater utilisation of the help which science can give will be a potent factor in the rehabilitation of existing industries, including agriculture, no less than in the development of new ones."

APPENDIX I.

Areas under new and improved varieties of crops in India during 1929-30 and 1930-31.

Name of Province	Name of crop	Area in acres								
		1928-29			1929-30			1930-31		
		Departmental seed	Natural spread	Total	Departmental seed	Natural spread	Total	Departmental seed	Natural spread	Total
					(a) British India.					
Madras	Paddy	18,082	197,849	215,931	19,216	226,110	245,326	19,832	272,646	292,478
	Sugarcane	1,256	8,534	9,790	805	4,516	5,321	240	21,080	21,321
	Cotton	81,340	344,128	425,468	93,400	166,787	260,187	86,865	213,707	300,572
	Miscellaneous	14,844	157,728	172,572	7,912	29,053	36,965	11,498	83,028	94,526
Bombay: Presidency Proper.	Cotton—									
	1027 A. L. F.	225,000	250,000	475,000	233,412	*	..	239,160	*	..
	Neglectum roseum	16,379	200,000	216,379	9,139	*	..	3,076	*	..
	Dharwar No. 1	77,510	12,500	90,010	59,800	*	..	50,000	*	..
	Gadag No. 1	76,906	62,500	139,406	72,300	*	..	78,600	*	..
	Punjab-American 4-F and 285-F.	14,000	21,471	35,471	..	*	..	..	*	..
	Deshi W. N.	8,000	52,000	60,000	..	*	..	..	*	..
	Wagad No. 6	607	..	607	150	*	..	150	*	..
	Banila (Dhulia No. 1	8,000	12,000	20,000	22,500	*	..	22,100	*	..
	Jayawant	..	..	..	1,020	*	..	17,210	*	..
	TOTAL COTTON	426,402	610,471	1,036,873	398,321	*	..	410,296	*	..

	Groundnut	7,385	420,380	427,765	395	*	..	5,694	*	..
	Sugarcane	313	2,200	2,513	198	*	..	142	*	..
	Bajra (Akola)	1,663	..	1,663	2,066	*	..	1,755	*	..
	Wheat	1,983	27,701	29,684	285	*	..	11,259	*	..
	Paddy (selected strains of Kolamba).	3,140	14,265	17,405	1,528	*	..	3,447	*	..
	Miscellaneous (Tobacco No. 6, Nagli, Onion, Guavas, Figs and Pomegranate).	836	277	1,113	1,193	*	..	1,534	*	..
Sind	Cotton—									
	4-F, 285-F	..	..	..	1,764	24,176	25,940	1,264	57,751	59,013
	Deshi 27 W. N.	..	..	..	8,865	31,200	40,065	4,395	26,615	31,010
	Wheat (Pusa 12, A. T. 38, Pusa 11 and Punjab 8-A).	..	..	..	1,321	83,000	84,321	1,657	84,395	86,052
	Paddy (Kangni, Prong and Jajai).	..	..	..	1,135	1,218	2,353	1,363	1,527	2,890
	Jowar	..	..	..	109	230	339	410	..	410
Bengal	Paddy (Indrasil, Dudsar, Jhingasail, Kataktara, Charnock and Surajamukhi).	10,518	174,737	185,255	12,185	180,000	192,885	5,676	217,557	223,233
	Jute (D. 154, Chinsura Green and K. B.).	54,478	1,083,127	1,137,605	76,352	1,100,000	1,176,352	22,346	1,019,156	1,041,502
	Sugarcane	8,041	58,978	670,919	14,305	60,000	74,305	32,066	67,934	100,000
	Other crops	839	3,009	3,848	699	3,000	3,699	552	17,264	17,816
United Provinces	Wheat (Pusa 4, 12, 52, 100, 110, Punjab 8-A, C-13, 46, Muzaffarnagar, etc.).	90,000	1,300,000	1,390,000	104,300	1,496,000	1,600,000	150,000	1,650,000	1,800,000
	Cotton (J. N. I. K. 22, A-19, A. W. F., C-204, 520, 1031 and 1035, American Cotton).	15,000	200,000	215,000	17,000	203,000	220,000	30,000	225,000	255,000
	Sugarcane (S. 48, Co. 205, 213, 214, 290, Uba, Barbados, Mauritius 16, etc.).	10,000	271,000	281,000	18,000	497,000	515,000	27,000	651,000	678,000

* Reliable figures not available.

Areas under new and improved varieties of crops in India during 1929-30 and 1930-31—contd.

Name of Province	Name of crop	Area in acres								
		1928-29			1929-30			1930-31		
		Departmental seed	Natural spread	Total	Departmental seed	Natural spread	Total	Departmental seed	Natural spread	Total
United Provinces—*contd.*	Barley (Balla, etc.)	8,000	22,000	30,000	9,000	23,000	32,000	10,000	24,000	34,000
	Gram (Pusa Yellow, black, etc.).	15,000	33,000	48,000	22,000	49,000	71,000	26,000	50,000	76,000
	Miscellaneous, (Jaunpur maize, Cawnpore Dudania *Juar*, Awned *bajra*, Large Japanese and Virginian groundnuts, jute, rice, etc.)	61,000	75,000	136,000	45,000	55,000	100,000	52,000	82,000	134,000
Punjab	Cotton—									
	American 4-F	153,020	820,050	973,070	163,300	637,490	800,790	..	..	798,400
	American 285-F	..	100	100	10	..	10	..	..	..
	American 289-F	..	..	..	3,650	1,350	5,000	..	..	36,900
	Deshi neglectum (white-flowered).	23,505	158,205	181,710	33,000	97,930	101,230	..	..	99,200
	Deshi indicum.	61,330	308,260	369,590	102,530	381,640	484,170	..	..	515,700
	TOTAL COTTON	237,855	1,286,615	1,524,470	202,480	1,118,410	1,391,200	..	..	1,450,200
	Wheats—									
	Punjab 11	..	..	..	750	134,300	135,050	..	..	75,650
	Punjab 8-A	95,125	2,004,405	2,099,530	110,800	1,747,100	1,857,900	..	..	2,292,400
	Other improved types Pusa 4, 12, etc.	..	..	..	800	522,850	523,650	..	..	79,950
	TOTAL WHEAT	95,125	2,004,405	2,099,530	112,350	2,404,250	2,516,600	..	..	2,448,000

	Sugarcane (Coimbatore)	5,239*	78,079*	83,318	3,850	76,150	80,000	..	..	104,400
Burma	Paddy	123,895	199,230	323,125	126,662	256,310	382,972	147,633	289,171	436,804
	Groundnut	1,055	12,928	13,983	420	13,930	14,350	469	20,501	20,970
	Cotton	4,520	2,050	6,570	4,000	1,002	5,002	4,890	4,500	9,390
	Gram	8,095	147,021	168,116	2,934	127,422	130,356	20,711	124,575	145,286
	Sugarcane	..	..	..	..	..	1,731	..	..	250
Bihar and Orissa	Paddy—									
	Dahia	1,047	12,744	13,791	1,201	15,396	16,597	950	7,094	8,044
	Kakharua, Kalamdan, Cuttack Nos. 1, 2, 3 and 4, Latisail, etc.	151	6,303	6,454	1,631	4,829	6,460	145	6,945	7,090
	TOTAL PADDY	1,198	19,047	20,245	2,832	20,225	23,057	1,095	14,039	15,134
	Sugarcane (Co. 205, 213)	1,366	44,722	46,088	884	80,780	81,664	336	101,782	102,118
	Groundnut (No. 17)	47	2,560	2,607	120	2,455	2,575	715	1,667	2,382
	Tobacco (Pusa 28)	25	215	240	60	480	540	..	500	500
	Gram (Sabour No. 4, Pusa No. 17).	96	301	397	62	413	475	28	889	917
	Wheat (Pusa 4, 12, 52, 80-5)	319	4,879	5,198	2,208	6,254	8,462	1,981	21,225	23,206
	Miscellaneous (Pusa Linseed 12, Sabour Peas 512, Dhaincha, Maize, *Rahar*, Elephant grass and Jute D. 154).	84	54	138	115	235	350	266	976	1,242
Central Provinces	Wheat	..	..	269,907	..	..	355,057	..	..	377,372
	Paddy	..	..	181,696	..	..	220,976	..	..	254,781
	Cotton	..	..	627,671	..	..	660,199	..	..	683,695
	Juar (*Sorghum*)	..	..	129,773	..	..	162,549	..	..	153,282
	Groundnut	..	..	75,024	..	..	85,170	..	..	115,831
	Sugarcane	..	..	..	..	..	1,350*	..	..	4,269*
	Other crops	..	..	20,187	..	..	19,466	..	..	37,343

* Figures supplied by the Sugar Technologist, Imperial Council of Agricultural Research.

Areas under new and improved varieties of crops in India during 1929-30 and 1930-31—contd.

Name of Province	Name of crop	Area in acres								
		1928-29			1929-30			1930-31		
		Departmental seed	Natural spread	Total	Departmental seed	Natural spread	Total	Departmental seed	Natural spread	Total
Assam	Rice	596	11,966	12,562	4,394	12,432	16,826	1,950	17,000	18,950
	Sugarcane	116	3,128	3,244	207	6,110	6,317	43	7,000	7,043
	Jute	514	5,546	6,060	1,211	61,995	63,206	1,320	62,000	63,320
	Potato	249	2,482	2,731	284	12,850	13,134	145	13,130	13,275
North-West Frontier Province.	Wheat (Pusa No. 4)	..	..	330,500	..	..	330,000	*	*	280,000
	Maize (Peshawar White, Iowa Silver Mine).	..	..	6,000	..	..	10,000	*	*	*
	Chillies (Peshawar Round)	..	..	4,000	..	..	5,000	*	*	*
	Sugarcane (Assami Red Partabgarh).	..	..	620	..	..	1,000	*	*	*
	Berseem	..	..	12,000	..	..	20,000	*	*	*
	Fruits (Peach, Plum, Apricot, Pear, Oranges, etc.).	..	..	3,100	..	..	6,000	*	*	*
(*b*) Indian States.										
Hyderabad	Cotton—									
	Gaorani	..	..	94,500	82,800	..	82,800	96,400	..	96,400
	Dharwar No. 1	..	..	..	..	..	..	10,850	..	10,850
	Gadag No. 1	..	..	..	..	..	..	2,850	..	2,850
	Banilla	..	..	..	..	..	..	4,000	..	4,000

	TOTAL COTTON .	..	..	94,500	82,800	..	82,800	114,100	..	114,100
	Groundnut (Kanki No. 17).	..	..	..	91	..	91	340	..	340
	Sugarcane (Co. 213) . .	..	..	..	..	..	..	26	..	26
Mysore† . .	*Ragi* H. 22 . . .	22,310	56,848	79,158	50,088	138,950	189,038	35,441	98,225	133,666
	Paddy	2,252	11,270	13,522	2,905	28,003	30,908	3,677	34,482	38,159
	Sugarcane . . .	1,246	3,118	4,364	627	2,994	3,621	1,781	4,632	6,413
	Cotton	6,640	5,090	11,740	8,687	8,285	16,972	11,043	12,120	23,163
	Groundnut . . .	2,667	69,886	72,553	1,413	66,181	67,594	711	105,295	106,006
	Miscellaneous (Jola, green manure, cardamom, potatoes, pepper, wheat, sunflower).	122	265	387	241	530	771	362	12,634	12,996
Baroda . . .	Cotton	14,250	..	..	5,251	79,803	85,054	6,897	*	*
	Paddy	250	..	..	70	8,050	8,120	56	105	161
	Wheat	60	..	..	55	1,006	1,061	35	..	..
Travancore . .	Paddy	438	..	..	350	750	1,100	261	1,000	1,261
Gwalior . .	Cotton (Malwi) . . .	4,189	..	..	2,500	..	..	*	*	*
	Jowar	913	..	..	4,000	..	..	*	*	*
	Wheats (Jalalia and Pusa 4)	1,909	..	..	500	..	..	*	*	*
Patiala . . .	Wheat	..	..	..	..	..	..	45,960	310,790	356,750
	Cotton . . .	..	..	..	..	..	..	2,400	162,600	165,000

* Figures not available.
† Areas shown are approximate. Figures for 1928-29 have been revised.

APPENDIX II.

List of Agricultural Stations in India in 1929-30 and 1930-31.

Province	Agricultural Station	Area in acres	Officer in immediate charge	Supervising Officer	Remarks
Imperial Department of Agriculture in India.	Pusa	726-732*	Farm Overseer	Imperial Agriculturist	Imperial Institute of Agricultural Research. * Cultivated area.
	Karnal	2,154	Superintendent	Imperial Dairy Expert	Cattle-breeding Farm.
	Bangalore	291	Ditto	Ditto	Dairy Farm.
	Wellington	149	Ditto	Ditto	Ditto.
	Coimbatore	90	Farm Manager	Sugarcane Expert	Cane-breeding Station.
Madras	Anakapalle	36	Ditto	Deputy Director of Agriculture, I Circle, Vizagapatam.	
	Samalkota	57	Ditto		
	Guntur	150	Ditto	Deputy Director of Agriculture, II Circle, Guntur.	
	Hagari	225	Ditto	Deputy Director of Agriculture, III Circle, Bellary.	
	Nandyal	88	Ditto		
	Palur	64	Ditto	Deputy Director of Agriculture, IV Circle, St. Thomas Mt.	
	Palakuppam	16	Ditto		
	Coimbatore (Cotton-breeding Station)	103	Superintendent	Cotton Specialist, Coimbatore.	
	Koilpatti	205	Ditto		
	Kasaragod	106	Farm Manager	Deputy Director of Agriculture, VII Circle, Tellicherry.	
	Taliparamba	86	Ditto		
	Vellalur	2	Ditto	Deputy Director of Agriculture, VIII Circle, Coimbatore.	Betel Vine Station.
	Coimbatore (Central Farm)	314	Ditto	Principal, Agricultural College, Coimbatore.	Central Farm attached to the Agricultural College.

Bombay Presidency (proper)	Coimbatore (Paddy-breeding Station)	22	Ditto	Paddy Specialist, Coimbatore.	
	Aduthurai	50	Superintendent		
	Maruteru	50	Ditto		
	Pattambi	82	Ditto		
	Coimbatore (Millet-breeding Station)	58	Farm Manager	Millet Specialist, Coimbatore.	
	Hosur	1,600	Superintendent	Deputy Director of Agriculture, Live-stock, Hosur.	Live-stock Research Stations.
	Chintaladevi	850	Ditto		
	Guntur	150	Farm Manager		
	Nanjanad	36	Ditto	Curator, Government Botanical Gardens and Parks, Ootacamund.	* Pomological Station . . 12 acres. Burliar Gardens . 8 ,, Kallar Gardens . 10 ,,
	Coonoor, Burliar and Kallar Gardens*	30	Assistant Farm Manager		
	Surat	292	Superintendent	Deputy Director of Agriculture, Gujarat, Surat.	Research and experiments in cotton and *jowar* breeding, maintaining and multiplying pure seed for distribution.
	Amalsad	19	Agricultural Overseer		Closed from 28th February 1931 due to retrenchment.
	Nadiad	11	Tobacco Breeder, Nadiad		Improvements in local varieties of tobacco for breeding the best strains and multiplying pure seed for distribution.
	Broach	10	Cotton Breeder, South Gujarat, Surat.		Breeding of cotton and *jowar* types.
	Dohad	68	Superintendent, Agricultural Station, Dohad.		Improving staple crop of maize, wheat, gram by selection and breeding. Frost-resistant variety of cotton.
	Viramgam	6	Cotton Breeder, North Gujarat, Viramgam.		Improvement in local types of Wagad by breeding and selection.
	Jalgaon	204	Superintendent	Deputy Director of Agriculture, N. C. D., Nasik.	
	Dhulia School Farm	28	Head Master, Vernacular Agricultural School, Dhulia.		
	Sangvi Farm	49	Manager, Sangvi Farm		Cattle-breeding Farm.

List of Agricultural Stations in India in 1929-30 and 1930-31—contd.

Province	Agricultural Station	Area in acres	Officer in immediate charge	Supervising Officer	REMARKS
Bombay Presidency (proper)—*contd.*	Kopergaon	25	Superintendent, Kopergaon Farm.	Deputy Director of Agriculture, S. C. D., Poona.	Sugarcane Confirmation Station.
	Baramati	21	Superintendent, Baramati Farm.		Closed from 1st June 1931.
	Manjri	72	Superintendent, Manjri Farm.		Sugarcane Experimental Station.
	Mohol	55	Overseer		This Farm is maintained for testing and showing methods of dry cultivation and land development in famine areas.
	Dharwar	146	Superintendent, Dharwar Farm.	Deputy Director of Agriculture, S. D., Dharwar.	
	Gokak	32	Superintendent, Gokak Farm.	Ditto	
	Mugad	9	Superintendent	Ditto	Rice-breeding Farm.
	Tegur	370	Fieldman	Ditto	Cattle-breeding Farm.
	Ratnagiri	22	Superintendent	Deputy Director of Agriculture, Konkan, Ratnagiri.	Rice breeding.
	Hatkhamba (Varkas Sub-Station)	71	Ditto	Ditto	Nagli breeding.
	Kumta (Forest attached to the Farm—35 acres).	22	Ditto	Ditto	
	Karjat	9	Rice Specialist, Karjat	Ditto	Rice Research Station.
	Karjat	6	Superintendent	Crop Botanist to Government, Karjat.	Rice-breeding Station.
	Niphad	5	Ditto		Wheat-breeding Station (transferred from Kirkee in 1930-31).
	Chharodi	2,278	Manager	Live-stock Expert to Government, Poona.	Cattle Farm.
	Bankapur	(1) 96 (2) 152	Ditto		(1) Farm area. (2) Grazing area at Kalasgeri attached to Farm.
	Ganeshkhind	80	Superintendent	Horticulturist to Government, Poona.	

	Botanical Gardens, Modibag	12	Ditto	Ditto.	
	Poona Agricultural College Farm	275	Superintendent	Professor of Agriculture, Poona.	
	Kirkee	362	Manager	Ditto.	Agricultural College Dairy.
Bombay—*contd.* (Sind)	Govt. Auxiliary Farm, Pad Idan	300	Ditto	Chief Agricultural Officer, Sind.	
	Govt. Auxiliary Farm, Oderolal	365	Ditto		
	Govt. Auxiliary Farm, Dadu	583	Ditto		
	Govt. Seed Farm, Mirpurkhas	200	Superintendent		For multiplication of improved types of cottons.
	Fruit Farm, Mirpurkhas	60	Horticulturist		Mainly devoted to experiments on fruit culture.
	Agricultural Station, Larkana	61	Superintendent		Rice, jowar and wheat breeding.
	Govt. Wheat Farm, Jacobabad	300	Ditto		Multiplication of improved wheat strains.
	Willingdon Cattle Farm, Malir	903	Manager		Breeding of milch cattle.
	Research Station, Sakrand	234	Officer-in-Charge and Agricultural Chemist and Soil Physicist.		Agricultural Research in connection with the establishment of conditions of perennial irrigation in Sind under the Lloyd Barrage. The Station includes a botanical, a chemical and an agricultural section in addition to a physiological section, financed by the Indian Central Cotton Committee, for work on the physiology of the cotton crop in Sind.
Bengal	Chinsurah	210	Farm Superintendent, Chinsurah.	Deputy Director of Agriculture, Western Circle.	
	Berhampore	44	District Agricultural Officer, Berhampore.		
	Bankura	29	District Agricultural Officer, Bankura.		
	Sur	33	District Agricultural Officer, Suri.		
	Krishnagar	53	District Agricultural Officer, Nadia.		

List of Agricultural Stations in India in 1929-30 and 1930-31—contd.

Province	Agricultural Station	Area in acres	Officer in immediate charge	Supervising Officer	Remarks
Bengal—*contd.*	Gosaba (24-Parganas)	8	Agricultural Officer, Gosaba	Deputy Director of Agriculture, Western Circle.	
	Jessore Khas Mahal Farm	5	District Agricultural Officer, Jessore.		
	Burdwan	35	District Agricultural Officer, Burdwan.		
	Rajshahi	68	Superintendent, Rajshahi Farm.	Deputy Director of Agriculture, Northern Circle.	
	Pabna	19	District Agricultural Officer, Pabna.		
	Bogra	23	District Agricultural Officer, Bogra.		
	Bogra Branch Farm	7	Ditto		
	Malda	16	District Agricultural Officer, Malda.		
	Dinajpur	24	District Agricultural Officer, Dinajpur.		
	Rangpur Demonstration Farm	19	District Agricultural Officer, Rangpur.		
	Mainaguri	25	District Agricultural Officer, Jalpaiguri.		
	Rangpur Cattle Farm	333	Superintendent, Rangpur Cattle Farm.	Live-Stock Expert, Bengal.	
	Government Tobacco Farm, Rangpur	52	Superintendent, Rangpur Tobacco Farm.	Agricultural Chemist, Bengal.	
	Dacca Central Farm	354	Chief Superintendent, Dacca Farm.	Deputy Director of Agriculture, Eastern Circle.	
	Jaidebpur Farm (Court of Wards)	11	Agricultural Demonstrator	Deputy Director of Agriculture, Eastern Circle, and District Agricultural Officer, Dacca.	
	Mymensingh Farm	20	District Agricultural Officer, Mymensingh.		

Jamalpur	35	District Agricultural Officer, Jamalpur.	Deputy Director of Agriculture, Eastern Circle.
Kishoreganj Farm	83	District Agricultural Officer, Kishoreganj.	
Dhanbari Farm	7	Agricultural Demonstrator	Deputy Director of Agriculture, Eastern Circle, and District Agricultural Officer, Kishoreganj.
Gayhatta C. W. Farm	4	Ditto	Deputy Director of Agriculture, Eastern Circle, and District Agricultural Officer, Jamalpur.
Baratia Private Farm	8	Ditto	
Faridpur Farm	20	District Agricultural Officer, Faridpur.	Deputy Director of Agriculture, Eastern Circle.
Rajbari Farm	10	Agricultural Demonstrator, Rajbari.	Deputy Director of Agriculture, Eastern Circle, and District Agricultural Officer, Faridpur.
Barisal Farm	20	District Agricultural Officer, Barisal.	Deputy Director of Agriculture, Eastern Circle.
Rangamati Farm	51	District Agricultural Officer, Rangamati.	Assistant Director of Agriculture, Bengal.
Charbadna Farm	67	Agricultural Demonstrator	Deputy Director of Agriculture, Eastern Circle, and District Agricultural Officer, Barisal.
Lalmohan Khasmahal Farm	6	Ditto	
Chandra Mohan Farm	14	Ditto	
Amtali Farm	1	Ditto	
Bargana Farm	3	Ditto	
Khepapara Colonisation Farm	6	Ditto	
Daulatkhan C. W. Farm	..	Ditto	
Comilla Farm	20	District Agricultural Officer, Comilla.	
Brahmanbaria Private Farm	5	Agricultural Demonstrator	Deputy Director of Agriculture, Eastern Circle, and District Agricultural Officer, Comilla.
Char Nilkamal K. M. Farm	2	Ditto	
Durgapur H. E. School Farm	5	Agricultural teacher attached to the School.	Deputy Director of Agriculture, Eastern Circle, and District Agricultural Officer, Chittagong.
Kalimpong Farm	75	Superintendent of Agriculture, Kalimpong.	Assistant Director of Agriculture.

List of Agricultural Stations in India in 1929-30 and 1930-31—contd.

Province	Agricultural Stations	Area in acres	Officers in immediate charge	Supervising Officer	Remarks
United Provinces	Shahjahanpur	165	Deputy Director	Deputy Director of Agriculture, Rohilkhand Circle.	
	Badaun	20	Overseer		
	Nawab Gunj (Bareilly)	120	Ditto		
	Nagina (Bijnor)	77	Superintendent		
	Jeolikote (Naini Tal)	51	Ditto		
	Tarikhet	17	Ditto		
	Cawnpore	71	Ditto	Deputy Director of Agriculture, Central Circle.	
	Kalianpore	263	Ditto		
	Mainpuri	53	Ditto		
	Etawah	61	Ditto		
	Hardoi	55	Ditto		
	Attara (Bonda)	171	Ditto	Deputy Director of Agriculture, Bundelkhand Circle.	
	Bela Tal (Hamirpur)	30	Overseer		
	Partabgarh	90	Superintendent	Deputy Director of Agriculture, Eastern Circle.	*Closed from Nov. 1, 1930.
	Naugawan (Sultanpur)*	360	Ditto		
	Fyzabad	206	Overseer		
	Benares	78	Superintendent		
	Aligarh	88	Ditto	Deputy Director of Agriculture, Western Circle.	
	Kalai (Aligarh)	142	Ditto		
	Muzaffarnagar	100	Ditto		
	Bichpuri (Agra)	100	Ditto		
	Jachonda (Muttra)	35	Inspector		
	Bulandshahr	25	Ditto		

Punjab	Meerut	76	Ditto		
	Gorakhpur	110	Overseer	Deputy Director of Agriculture, North-Eastern Circle.	
	Bahraich	100	Ditto		
	Lyallpur Agricultural Station	425	Agricultural Assistant	Professor of Agriculture, Punjab Agricultural College, Lyallpur.	
	Lyallpur Students' Farm	78	Ditto	Ditto.	
	Lyallpur Botanical Farm and Fruit Garden.	113	Associate Professor of Botany.	Associate Professor of Botany, Punjab Agricultural College, Lyallpur.	
	Risalewala	802	Agricultural Assistant	Professor of Agriculture, Punjab Agricultural College, Lyallpur.	Mainly a seed farm.
	Cotton Research Botanist Farm, Risalewala.	220	Cotton Research Botanist	Cotton Research Botanist, Lyallpur.	Cotton experiments.
	Cotton Research Botanist Farm, Lyallpur.	18	Ditto	Ditto.	Ditto.
	Jhang Farm	200	Agricultural Assistant	Deputy Director of Agriculture, Lyallpur.	District Farm.
	Montgomery Agricultural Station	681	Ditto	Deputy Director of Agriculture, Montgomery.	Experimental Farm.
	Shergarh Farm	1,511	Ditto	Ditto	Seed Farm.
	Fatna Farm	528	Ditto	Ditto	Seed Farm.
	Bara Farm	559	Ditto	Ditto	For reclamation of Saline Soils.
	Gurdaspur Agricultural Station	263	Ditto	Deputy Director of Agriculture, Gurdaspur.	Experimental Farm.
	Beas Farm	36	Ditto	Ditto	District Farm.
	Attari Farm	101	Ditto	Ditto	Ditto.
	Gujranwala Farm	107	Ditto	Ditto	Ditto.
	Kala Shah Kaku Rice Farm	381	Ditto	Ditto	Rice-breeding Station.
	Rawalpindi Agricultural Station	252	Ditto	Deputy Director of Agriculture, Rawalpindi.	Experimental Station.
	Campbellpur Farm	100	Ditto	Ditto	District Farm.
	Gujrat Farm	45	Ditto	Ditto	Ditto.

List of Agricultural Stations in Indra in 1929-30 and 1930-31—contd.

Province	Agricultural Station	Area in acres	Officer in immediate charge	Supervising Officer	REMARKS
Punjab—*contd.*	Chillianwala Seed Farm	250	Agricultural Assistant	Deputy Director of Agriculture, Rawalpindi.	Seed Farm.
	Sargodha Seed Farm	155	Ditto	Ditto	Ditto.
	Sargodha Agricultural Station	500	Ditto	Ditto	Experimental Station and Seed Farm.
	Hansi Agricultural Station	589	Ditto	Deputy Director of Agriculture, Hansi.	Experimental Station.
	Sirsa Agricultural Station	402	Ditto	Ditto	Ditto.
	Ferozepore Farm	100	Ditto	Ditto	District Farm.
	Gurgaon Farm	100	Ditto	Ditto	Ditto.
	Rohtak Farm	100	Ditto	Ditto	Ditto.
	Amballa Farm	100	Ditto	Ditto	Ditto.
	Karnal Farm	100	Ditto	Ditto	Ditto.
	Multan Agricultural Station	529	Ditto	Deputy Director of Agriculture, Multan.	Experimental Station.
	Vihari Seed Farm	500	Ditto	Ditto	Seed Farm.
	Mianwali Farm	207	Ditto	Ditto	District Farm.
	Ludhiana Farm	54	Ditto	Deputy Director of Agriculture, Jullundur.	Ditto.
	Kangra Farm	10	Ditto	Ditto	Ditto.
	Jullundur Agricultural Station	119	Ditto	Ditto	Agricultural Station.
	Hmawbi	456	Farm Superintendent	Deputy Director of Agriculture, Southern Circle, Rangoon.	
	Mandalay	630	Ditto	Professor of Agriculture, Mandalay.	
	Kanbalu	534	Ditto	Deputy Director of Agriculture, Northern Circle, Mandalay.	
	Mahalaing	254	Ditto	Deputy Director, Myingyan Circle, Meiktila.	

Burma	Pyinmana	55	Ditto	Deputy Director, East Central Circle, Pyinmana.	
	Tatkon	106	Ditto		
	Allanmyo	144	Ditto	Deputy Director, West Central Circle, Magwe.	
	Sa-aing	11	Ditto		
	Myaungmya	92	Ditto	Deputy Director, Irrawaddy Circle, Myaungmya.	
	Mudon	88	Ditto	Deputy Director, Tenasserim Circle, Moulmein.	
	Akyab	138	Ditto	Deputy Director, Arakan Circle, Akyab.	
	Kyaukpyu	23	Ditto		
	Paukkaung	16	Ditto	Entomologist, Mandalay.	
Bihar and Orissa	Cuttack	150	Manager	Assistant Director of Agriculture, in charge of Orissa Range.	
	Khurda	31	Overseer		
	Balasore	75	Ditto		
	Angul	47	Ditto		
	Puri	42	Ditto		
	Kujang *	30	Ditto		*Of which 26·2 acres were presented by the Hon'ble Maharaja of Burdwan.
	Sepaya	379	Manager	Deputy Director of Agriculture, North Bihar Range.	
	Siwan	25	Overseer		
	Dharbanga	26	Ditto		
	Purnea	60	Assistant Director of Agriculture.		
	Byreah (District Champaran)	316	Farm Manager	Manager, Bettiah Raj (Court of Ward's Farm).	
	Sabour	190	Assistant Director of Agriculture.	Assistant Director of Agriculture, in charge of South East Bihar Range.	
	Monghyr * (Dairy farm)	200	Manager		*Monghyr Dairy Farm abolished from August 1931.
	Jamui	38	Overseer		
	Banka	26	Ditto		
	Gaya	193	Manager	Deputy Director of Agriculture, in charge of South Bihar Range.	

List of Agricultural Stations in India in 1929-30 and 1930-31—contd.

Province	Agricultural Station	Area in acres	Officer in immediate charge	Supervising Officer	Remarks
Bihar and Orissa—*contd.*	Patna	200	Overseer	Deputy Director of Agriculture, in charge of South Bihar Range.	
	Nawadah	83	Ditto		
	Bikramganj	24	Ditto		
	Siris	35	Ditto		
	Kanke	340	Manager	Deputy Director of Agriculture, Chota Nagpur Range.	
	Netarhat	193	Overseer		
	Purulia	52	Ditto		
	Ramgarh	43	Ditto		
	Chianki	32	Ditto		
	Sambalpur	32	Ditto		
	Chaibassa	38	Ditto		
	Akola	272	Superintendent	Economic Botanist, C. P.	
	Chhindwara	69	Ditto	Deputy Director of Agriculture.	
	Powarkhera	528	Ditto		
	Adhartal	299	Ditto		
	Nagpur	286	Ditto	Principal, Agricultural College, Nagpur.	
	Labhandi	229	Ditto		Demonstration Farm.
	Tharsa	116	Ditto		
	Basim	110	Ditto		
	Waraseoni	63*	Ditto		*Cropped area.
	Betul	160	Ditto		
	Bilaspur	253	Ditto		
	Buldana	135	Ditto		

Central Provinces	Sindewahi	150*	Ditto	Deputy Director of Agriculture.	* Cropped area.
	Damoh	152	Ditto		
	Drug	281	Ditto		
	Khandwa	177	Ditto		
	Chandkhuri	110*	Ditto		*Cropped area.
	Saugor	161	Ditto		
	Seoni	170	Ditto		
	Yeotmal	106	Ditto		
	Narsinghpur	87	Ditto		
	Drug	..	Ditto	Deputy Director of Agriculture in charge, Animal Husbandry.	Cattle-breeding Farm.
	Ellichpur	300	Ditto		
	Powarkhera	..	Ditto	Deputy Director of Agriculture.	(Attached to the Experimental Farm, Powarkhera.)
	Adhartal	339	Ditto		
	Telinkheri	1,000	Ditto	Deputy Director of Agriculture in charge, Animal Husbandry.	Central Breeding Farm.
	Chandkhuri	†	Ditto	Deputy Director of Agriculture.	
	Khandwa	†	Ditto		
	Garhi	1,223	Ditto	Deputy Director of Agriculture in charge, Animal Husbandry.	
	Bod	2,906	Ditto		
	Pendra	2,500	Ditto		
	Boregaon	378	Ditto	Deputy Director of Agriculture.	
	Bilaspur	†	Ditto		
Assam	Upper Shillong	366	Farm Manager	Live-stock and Dairy Expert, Assam.	Cattle breeding, potatoes and fodder crops.
	Khanapara	197	Ditto		Cattle and fodder crops.
	Jorhat	59	Ditto	Deputy Director of Agriculture, Upper Assam Valley.	Sugarcane.
	Titabar	125	Ditto		Rice.
	Karimganj	80	Ditto	Deputy Director of Agriculture, Surma Valley.	Do.

† These farms are attached to the Demonstration Farms.

List of Agricultural Stations in India in 1929-30 and 1930-31—contd.

Province	Agricultural Station	Area in acres	Officer in immediate charge	Supervising Officer	Remarks
N.-W. F. P.	Tarnab	200	Manager	Agricultural Officer, N.-W. F. Province.	
	Haripur	20	Ditto		
Hyderabad	Himayatsagar, Hyderabad	299	Superintendent, Government Main Farm.	Deputy Director of Agriculture, Telingana.	Main Farm.
	Cattle-breeding Farm, Himayatsagar *	600	Superintendent, Cattle-breeding Farm.		Cattle breeding opened in 1930-31.
	Nizamsagar (District Nizamabad)	6	Superintendent, Nizamsagar.		
	Mahbubnagar	176	Superintendent, Mahbubnagar Farm.		
	Sangareddy	101	Superintendent, Sangareddy Farm.		
	Parbhani	264	Superintendent, Government Main Farm.	Deputy Director of Agriculture, Mahratwara.	Main Farm.
	Alir	63	Superintendent, Alir Farm	Deputy Director of Agriculture, Telingana.	
Mysore	Agricultural Experimental Farm, Hebbal, Bangalore.	74	Farm Manager	Economic Botanist.	
	Agricultural Experimental Farm, Botanical Section breeding plots.	..	Agricultural Inspector		
	Marthur Farm (Shimoga District)	52	Farm Manager	Deputy Director of Agriculture, Shimoga Circle.	
	Babbur Farm (Chitaldrug District)	218	Manager	Director of Agriculture in Mysore.	
	Babbur Farm for Cotton, Jola and Coconut Breeding.	..	Senior Assistant Botanist	The Economic Botanist.	
	Paddy-breeding Station, Nagenhalli, Mysore District.	65	Junior Assistant Botanist		
	Kar Ragi-breeding Station, Hunsur, Mysore District.	42	Ditto		

Baroda	Coffee Experimental Station, Balehonnur, Kadur District.	290*	Manager	Deputy Director of Agriculture, Chikmagalur Circle.
	Cattle-breeding Station (Main and Sub-Stations), Ajjampur, Kadur District.	5,836	Manager, Main Station	Live-stock Expert.
			Manager, Sub-Station	
	Yelachihalli Sheep Farm	400	Agricultural Inspector	
	Mysore Irwin Canal Farm	600†	..	Agricultural Chemist on Soil Surveys.
	Agricultural Experimental Station, Baroda.	84	Superintendent	Deputy Director of Agriculture for Baroda District.
	Agricultural Experimental Station, Jagudan.	17·6	Ditto	Director of Agriculture.
	Agricultural Experimental Station, Amreli.	39·4	Ditto	
Travancore	Fruit Farm, Cape Comorin	16	Agricultural Inspector	Director of Agriculture and Fisheries.
	Paddy Farm, Nagercoil	40	Ditto	
	Cattle-breeding Farm, Easanthimangalam.	7	Veterinary Inspector	
	Demonstration Farm, Eranicl	17	Agricultural Sub-Inspector	Agricultural Inspector.
	Cattle Farm, Trivandrum	100	Agricultural Inspector	Director of Agriculture and Fisheries.
	Experimental Farm, Karamanai	100	Ditto	
	Experimental Farm, Kottarakara	100	Agricultural Sub-Inspector	
	Pepper Farm, Koni	150	Agricultural Inspector	
	Demonstration Farm, Puliyara	40	Ditto	
	Coconut Farm, Oachira	4	Agricultural Demonstrator	Agricultural Inspector.
	Coconut Farm, Chettikulangara	5	Ditto	
	Coconut Farm, Alleppey	9	Ditto	
	Coconut Farm, Vaikom	5	Agricultural Inspector	Director of Agriculture and Fisheries.
	Green Manure Farm, Vongola	5	Agricultural Sub-Inspector	
	Demonstration Farm, Alwaye	13	Head Master, Agricultural School, Alwaye.	

* Of this 82 acres are under coffee, 20-25 years old. 25 acres have been planted with selections from high yielding mother trees from estates throughout S. India.
† A combined experimental demonstration and seed farm for the Irwin Canal tract (opened in 1930-31).

List of Agricultural Stations in India in 1929-30 and 1930-31—concld.

Province	Agricultural Station	Area in acres	Officer in immediate charge	Supervising Officer	REMARKS
Gwalior State	Gwalior	265	Farm Manager	Deputy Administrative Officer, Agricultural Section, Gwalior Division, Gwalior.	
	Ujjain	240	Ditto	Deputy Administrative Officer, Agricultural Section, Malwa Division, Ujjain.	
Bhopal	Nabi Bagh	170	Assistant Director of Agriculture.	Director of Agriculture.	Principal Experimental Farm.
	Nazahat Afza	41	Ditto		
	Nishat Afza	5	Ditto		Sugarcane Research Station.
	Int-Kheri	70	Ditto		Sugarcane Farm.
Patiala	Bhupindra Agricultural Farm, Patiala	100	..	Ditto.	

APPENDIX III.

Staffs of Provincial and State Departments of Agriculture in India during 1929-30 and 1930-31.

Province.	RESEARCH AND TEACHING STAFF											
	SUPERIOR SERVICE				PROVINCIAL SERVICE				SUBORDINATE SERVICE			
	Sanctioned cadre		Filled substantively		Sanctioned cadre		Filled substantively		Sanctioned cadre		Filled substantively	
	1929-30	1930-31	1929-30	1930-31	1929-30	1930-31	1929-30	1930-31	1929-30	1930-31	1929-30	1930-31
(a) British India.												
Madras	8	6	7	6	21	21	21	20	116	115	104	111
Bombay	6	6	6	6	15	15	15	15	28	28	28	24
Bengal	6	7	6	7	5	5	4	5	34	38	34	38
United Provinces	8	8	7†	7	10′ ‡	11	9	9	45	45	45	45
Punjab	18 (*a*)	17 (*b*)	17 (*a*)	14 (*b*)	15 (*d*)	15 (*b*)	15 (*d*)	15 (*b*)	58	64	58	64
Burma	4	4	3	3	11	11	9	9	18	18	13	13
Bihar and Orissa	2	3	..	1	4	4	3	4	3	3	3	3
Central Provinces	2	2	2	2	9	10	7	6	17	22	17	22
Assam	2	2	2	2	..	..	..	..	10	11	10	11
North-West Frontier Province	1	1	..	1	1	1	..	1	2	6	..	5
(b) Indian States.												
Hyderabad	1	1	1	1	1	1	1	1	4	4	4	4
Mysore	1	1	1	1	19	19	19	19	88	88	88	88
Baroda	..	1	..	1	..	2	..	1	..	3	..	3
Travancore	1	1	1	1	6	4	6	2	4	12	4	12

† Includes 5 I. A. S. posts and 2 U. P. A. S.—posts replacing I. A. S. post held in abeyanc
‡ Includes one temporary.

(*a*) Includes 13 temporary. (*b*) Includes temporary staff. (*d*) 1 temporary.

APPENDIX III—*contd.*

Staffs of Provincial and State Departments of Agriculture in India during 1929-30 and 1930-31—contd.

Province.	DISTRICT STAFF											
	SUPERIOR SERVICE				PROVINCIAL SERVICE				SUBORDINATE SERVICE			
	Sanctioned cadre		Filled substantively		Sanctioned cadre		Filled substantively		Sanctioned cadre		Filled substantively	
	1929-30	1930-31	1929-30	1930-31	1929-30	1930-31	1929-30	1930-31	1929-30	1930-31	1929-30	1930-31
(a) British India.												
Madras	7	8	7	8	17	18	16	17	237	259	226	243
Bombay	9	9	9	8	8	8	8	8	275	275	275	272
Bengal	3	4*	1	2*	5	8*	4	7*	163	265*	147	199*
United Provinces	12	12	9‡	9	16	17	16	17	131	148	131	148
Punjab	10 (*h*)	10 (*b*)	9 (*c*)	9 (*b*)	23 (*e*)	23 (*b*)	23 (*e*)	22 (*b*)	592 (*f*)	589 (*b*)	500 (*g*)	481 (*b*)
Burma	11	11	7	7	21	21	7	7	84	86	65	66
Bihar and Orissa	8	7	4	3	11	12	11	12	116	119	93	93
Central Provinces	8	8	7	6	13	12	11	10	125	132	124	105
Assam	3	3	3	2	3	3	3	3	17	17	17	17
North-West Frontier Province	..	1	..	1	..	1	..	1	9	8	..	..
(b) Indian States.												
Hyderabad	3	3	3	3	5	5	5	5	25	25	25	25
Mysore	..	..	..	..	..	17	..	17	..	341	..	341
Baroda	..	..	..	..	..	6	..	6	..	26	..	26
Travancore	..	..	..	..	7	8	7	8	8	..	8	..

* Includes sericulture staff also.
‡ Includes one temporary.

(*b*) includes temporary staff. (*c*) 1 temporary. (*e*) 1 temporary. (*f*) 111 posts temporary.
(*g*) 21 temporary. (*h*) 2 temporary.

APPENDIX IV.

Showing results of well-boring in India during 1929-30 and 1930-31.

Province.	1928-29		1929-30		1930-31	
	Number of bores	Number successful	Number of bores	Number successful	Number of bores	Number successful
(a) British India.						
Madras	746	473	549	376	337	228
Bombay	254	149	312	182	68	39
Bengal	130	122	212	210	39	38
United Provinces	1,552	1,227	1,543	1,137	1,402	1,070
Punjab	966	774	935	786	887	686
Bihar and Orissa	303	287	289	238	222	197
	3,951	3,032	3,840	2,929	2,955	2,258
(b) Indian States.						
Hyderabad	58	52	53	44	65	56
Mysore	18	16	24	18	....	....
Baroda	32	18	59	39	32	26
Patiala	22	20	....	....	11	8

APPENDIX V.

Showing sale of improved implements through departmental agency in India during 1929-30 and 1930-31.

Province	Ploughs			Cane Mills			Fodder Cutters		
	1928-29	1929-30	1930-31	1928 29	1929-30	1930-31	1928-29	1929-30	1930-31
(a) British India.									
Madras	2,045	1,235	753	25	64	11	29	26	36
Bombay Presidency proper	397*	546	255	15*	31	25	6*	9	..
Sind	..	499	671	..	..	..	..	7	..
Bengal	47	51	43	..	4	2	..	1	2
United Provinces	5,049	5,954	4,954	130	298	217	58	155	137
Punjab	7,510	8,886	9,434	915	2,647	4,996	7,142	14,258	12,570
Burma	4,483	6,784	6,137	15	16	6	2	5	13
Bihar and Orissa	324	802	565	24	36	326	6	4	4
Central Provinces	7,613	5,639	2,700	162	129	112	98	45	38
Assam	5	..	..	108	77	97	..	..	..
N.-W. F. P.	5	..	1	..	..	..	..	..	..
Total	27,478	30,396	25,513	1,394	3,302	5,792	7,341	14,510	12,800
(b) Indian States.									
Hyderabad	..	70	77	..	1	1	..	6	1
Mysore	1,791†	2,892	1,550	30†	103	47	..	..	..
Travancore	765	342	8	..	..	..	..	..	..
Baroda	66	35	27	..	..	..	..	3	1

* Includes Sind. † Revised

APPENDIX V—*contd.*

Showing sale of improved implements through departmental agency in India during 1929-30 and 1930-31—contd.

Province	Hoes			Other implements			Spare parts		
	1928-29	1929-30	1930-31	1928-29	1929-30	1930-31	1928-29	1929-30	1930-31
(a) British India.									
Madras	19	30	3	541	445	330	3,967	2,020	1,239
Bombay Presidency proper	29*	36	31	715*	319	346	204*	184	316
Sind	..	3	..	..	137	76	..	100	626
Bengal	13	2	8	4	2	1	9	5	6
United Provinces	40	29	36	199	387	468	8,242	10,939	8,648
Punjab	125	163	366	2,435	2,141	2,448	4,891	9,363	4,008
Burma	5	55	38	146	49	186	967	1,000	661
Bihar and Orissa	..	18	3	16	54	76	2	..	256
Central Provinces	99	132	462	877	1,207	974	11,494	17,116	14,324
Assam	..	5	1	50	49	44	60	34	41
North-West Frontier Province	..	..	1	2	..	..	12	..	4
TOTAL	330	473	949	4,985	4,790	4,944	29,848	40,761	20,129
(b) Indian States.									
Hyderabad	..	1	33	..	13	..	..	..	3
Mysore	164†	325	107	23†	04	413	4,129†	7,816	4,104
Travancore	..	..	..	..	..	..	..	..	..
Baroda	..	2	..	..	..	1	..	..	..

* Includes Sind. † Revised.

APPEN

Improved seeds and manures distributed

Province	SEED DIS					
	SEED GRAIN IN CWT.			NO. OF WHOLE CANES EXCEPT WHERE OTHERWISE STATED		
	1928-29	1929-30	1930-31	1928-29	1929-30	1930-31
(a) British						
Madras	17,971	11,823	10,434	72,515 12,550 setts	451,624	2,314,223
Bombay Presidency proper	*25,324	16,539	25,371	*64,090	64,191	203,040
Sind	..	3,729	4,918	..	5 cwts.	9 cwts.
Bengal	4,688	3,435	8,885	2,237,268	961,861	1,405,305
United Provinces	92,965	96,132	132,822	291,523 cwts.	369,848 cwts.	646,472 cwts.
Punjab	62,509	†	49,140	†	†	†
Burma	62,660	63,900	86,400	82,410	95,825	450,540
Bihar and Orissa	1,435	4,066	3,435	28,519 cwts.	1,713,632	619,351
Central Provinces	322,472	433,230	362,542	898,273	2,846,844	1,081,312
Assam	589	2,061	1,759	53,012	341,690 setts	278,329
North-West Frontier Province	223	..	179	25 cwts.	..	3·57 cwts.
TOTAL	590,240	634,924	685,885	..	..	..
(b) Indian						
Hyderabad	..	34,629	20,378	..	..	564 cwts.
Mysore	1,110	1,027	3,491	2,019,930	2,014,888	2,662,894
Baroda	3,199	230	704	..	4,200	..
Travancore	312	312	233	..	..	..
Bhopal	130	..	..	128,300	..	..
Patiala	193	..	658	..	..	68 cwts.

* Including Sind. † Not available.

DIX VI.

through departmental agency in India during 1929-30 and 1930-31.

TRIBUTED			MANURES DISTRIBUTED					
FRUIT PLANTS No.			COMMERCIAL FERTILIZERS IN CWT.			OIL CAKES IN CWT.		
1928-29	1929-30	1930-31	1928-29	1929-30	1930-31	1928-29	1929-30	1930-31
India.								
160,449	740,908	39,931	161,195	31,184	‡	34,949	8,895	‡
*24,629	24,500	31,634	4,891	6,918	9,170	129	389	376
..	617	591	..	13	3	..	..	..
157	330	100	653	311	350	89	89	133
15,369	13,859	15,599	2,281	9,912	9,528	11,525	13,321	22,729
†	†	(a) 5,650	†	†	†	†	†	†
817	1,247	1,896	96	393	2,325	..	362	..
1,200	758	554	5,220	13,269	7,058	..	..	..
5,906	2,983	5,010	1,636	1,906	1,882	472	437	562
4,998	4,327	7,992	4,503	1,841	1,375	101	38	97
17,500	17,000	20,000	..	..	24	..	..	..
231,034	806,529	128,957	181,475	65,747	31,715	47,265	23,531	23,897
States.								
..	..	..	..	273	42	..	9	353
11,184	21,582	9,300	15,920	2,730	3,809	310	60	237
1,229	4,032	2,039	131	173	160	..	..	..
3,820 Rs. worth	..	..	867	300	170	..	..	..
..	..	..	100	..	..	..	..	..
..	..	270	..	..	..	..	..	..

* Including Sind.

† Not available.

(a) Nursery plants . 4,400 } 5,650
Cuttings . . 1,250 }

‡ Not distributed through departmental agency in this province.

APPENDIX VII.

Demonstration and propaganda work in India during 1929-30 and 1930-31.

Province	Number of agricultural shows held			Number of practical demonstrations carried out			Number of illustrated lectures given		
	1928-29	1929-30	1930-31	1928-29	1929-30	1930-31	1928-29	1929-30	1930-31
(a) British India.									
Madras	252	255	153	7,060	6,293	7,048	305	541	459
Bombay Presidency proper	38*	37	29	1,167*	1,468	1,610	176*	208	186
Sind	..	1	5	..	247	428	..	12	6
Bengal	35	33	38	2,613	2,427	2,861	130	115	177
United Provinces	89	93	112	26,453	23,664	18,846	642	277	335
Punjab (a)	..	..	..	..	..	..	..	..	..
Burma	32	32	23	842	1,017	1,182	102	246	204
Bihar and Orissa	7	17	15	3,603	5,083	7,937	1	30	4
Central Provinces	38	38	23	4,040	4,371	4,200	160	285	343
Assam	6	5	5	1,703	1,538	1,953	25	37	73
North-West Frontier Province	..	..	..	..	..	..	..	..	..
TOTAL	497	511	403	47,481	46,108	46,065	1,541	1,751	1,787
(b) Indian States.									
Hyderabad	..	1	4	..	264	415	..	17	23
Mysore	4	..	40	814	675	1,688	..	..	164
Baroda	..	3	2	..	1	..	..	..	..
Travancore	4	4	5	350	..	..	..	..	..
Patiala	17	..	17	31	..	766	..	..	..

* Including Sind.
(a) Figures not available.

APPENDIX VIII.

Agricultural Colleges and Schools in India during 1929-30 and 1930-31.

APPENDIX

Agricultural Colleges and Schools

Name of college or school	Courses of instruction	1928-29			
		Applications for admission	Admissions made during the year	Total number on the roll	Number passed in final examination
(a) BRITISH					
(i) Post graduate					
Agricultural Research Institute, Pusa.	(1) Two-year Post-graduate Course.	26	6	11	2
	(2) One year Post-graduate course in farm management and organization and general farm-engineering.	..	..	..	..
	Special courses . .	..	..	..	..
Imperial Institute of Animal Husbandry and Dairying, Bangalore.	Fifteen-month Post-graduate Course.	..	3	7	4
	Twenty-four-month Course.	..	..	1	..
	Two-year Indian Dairy Diploma Course.	..	4	31	3
	Short Course . .	21	21	21	16
Imperial Cane Breeding Station, Coimbatore.	No regular course, but facilities given to study the methods of cane breeding.	5	5	5	..
(ii) Provincial Agri					
Agricultural College, Coimbatore.	Three-year B. Sc. Ag. Degree Course.	307	41	121	19
Agricultural College, Poona.	Three-year B. Ag. Degree Course.	187	75	216	60
	College Diploma Course .	..	..	..	4
Agricultural College, Cawnpore.	Four-year L. Ag. Diploma Course in 1929-30 and B. Sc. Degree (in 1930-31).	182	50	131	8
	Two-year Certificate Course.	113	30	46	13
Punjab Agricultural College, Lyallpur.	Four-year B. Sc. Ag. Degree Course.	412§	44	253	28
	One-and-a-half year M. Sc. Degree Course.	7	4	6	1
	Two-year certificate Course.	..	..	18	15
	Six-month Vernacular Course (Summer Class).	231	38	38	37
	Six-month Vernacular Course (Winter class).	171	41	41	39
	One-month Rural Economy Course.	21	21	21	21
	Ten-and-a-half-month Teachers' Training Course.	59	35	31	28
	Six-week Blacksmith Class.	39	17	17	17

VIII.

in India during 1929-30 and 1930-31.

1929-30				1930-31				REMARKS
Applications for admission	Admissions made during the year	Total number on the roll	Number passed in final examination	Applications for admission	Admissions made during the year	Total number on the roll	Number passed in final examination	
INDIA.								
Training Institutions.								
36	6	14	3	30	5	16*	5	*One left after 9 months.
..	2	2†	..	..	2	3	1	†One left after 5 months.
..	2	4	3	..	..	1	1	‡One left without completing the ocurse.
9	5	9	4	5	3	8‡	5	
..	..	..	..	..	..	..	..	
64	24	61	22	..	..	24	..	
54	54	54	54	8	8	8	8	
1	1	3	3	1	1	1	1	
cultural Colleges.								
303	46	125	33	..	..	..	..	
169	86	235	52	139	80	210	54	
..	..	..	1	..	..	..	3	
270	47	156	27	155	42	152	32	
81	18	36	19	81	21	32	13	
274§	95	52	34	110	40	264	57	§Total number of applications receiving for admission to leaving certificate and Degree Course.
..	..	3	..	1	1	4	3	
..	..	8	8	..	..	..	..	
‖	32	32	2	‖	32	27	21	
‖	39	39	32	‖	34	34	28	
23	23	22	22	23	23	23	23	
43	30	27	25	44	28	25	23	
27	25	14	9	27	13	13	13	

‖ Applications for admission were received by respective D. D. A.'s and selection was made by them.

Agricultural Colleges and Schools

Name of College or School	Courses of instruction	1928-29. Applications for admission	Admissions made during the year	Total number on the roll	Number passed in final examination
(ii) Provincial Agri					
Agricultural College, Mandalay.	Three-year Diploma Course.	60	22	43	10
Agricultural College, Nagpur.	Four-year Degree Course	91	51	40	5
	Four-year College Diploma Course.				3
(iii) Agricul					
Madras.					
Agricultural Middle School, Taliparamba.	Two-year Course . .	40	19	44	17
Bombay.					
Vernacular Agricultural School, Loni.	Ditto . .	93	18	39	15
Vernacular Agricultural School, Devlhosur.	Ditto . .	68	12	27	13
Vernacular Agricultural School, Jambur.	Ditto . .	10	8	20	8
Vernacular Agricultural School, Godhra.	Ditto . .	47	18	18	16
Vernacular Agricultural School, Dhulia.	Ditto . .	49	17	31	13
Vernacular Agricultural School, Surat.	Ditto . .	37	15	31	31
Bengal.					
Secondary Agricultural School, Dacca.	Two-year Course for regular students and one-year Course for Demonstrators.	27	26	29	3
United Provinces.					
Vernacular Agricultural School, Bulandshahr.	(1) Two-year Vernacular Course.	90	36	33	28
	(2) Teachers' Training Class.	12	12	12	13
	(3) Fieldmen's Course .	..	..	..	..
	(4) Engine Drivers' Course.	10	10	10	5
	(5) Garden Overseers' Course.	12	10	10	..
Punjab.					
Agricultural Vernacular Class, Gurdaspur.	Six-month Vernacular Course (Summer Class).	75	30	30	30
	Six-month Vernacular Course (Winter Class).	100	32	32	32

in India during 1929-30 and 1930-31—contd.

1929-30				1930-31				Remarks
Applications for admission	Admissions made during the year	Total number on the roll	Number passed in final examination	Applications for admission	Admissions made during the year	Total number on the roll	Number passed in final examination	
cultural Colleges—*contd.*								
77	19	34	8	77	23	33	18	
137	48	115	19	132	34	126	9	
tural Schools.								
41	17	23	14	..	..	..	..	
73	25	37	18	58	23	35	19	
51	21	32	13	128	24	37	13	
24	31	20	7	20	20	30	10	
30	9	15	14	21	17	27	8	
50	16	31	15	81	17	32	15	
19	13	25	21	22	15	26	10	
74	32	59	27	58	27	52	28	
89	37	66	32	91	37	64	29	
43	43	43	12	33	33	33	43	
5	5	5	5	8	8	8	5	
18	10	10	9	25	10	10	9	
10	10	9	9	10	1	1	1	
42	37	31	31	37	25	22	22	
40	27	25	25	23	12	10	10	

Agricultural Colleges and Schools

Name of College or School	Courses of instruction	1928-29			
		Applications for admission	Admissions made during the year	Total number on the roll	Number passed in final examination
					(iii) Agricul
Agricultural Vernacular Class, Hansi.	Six-month Vernacular Course (Summer Class).	79	35	21	15
	Six-month Vernacular Course (Winter Class).	50	38	23	10
Burma.					
Agricultural School, Pyinmana.	Four-year Course . .	..	54	65	9
	Two-year Course . .				
Central Farm School, Hmawbi.	Short-course of practical training for 9 months.	..	10	10	6
	Short-course of practical instruction.	..	35	35	35
Central Farm School, Mahlaing.	Short-course of practical training for 10½ months.	..	12	7	7
Central Farm School, Mudon.	Short-courses of practical instruction.	..	..	..	..
Central Farm School, Tatkon.	Ditto .	..	21	21	21
Central Farm School, Padu.	Ditto .	..	14	12	12
Central Farm School, Allanmyo.	Ditto .	..	50	50	50
	For one-year . .	..	..	..	..
Central Provinces.					
Agricultural Middle School, Powarkhera.	Four-year Course . .	52	35	82	10
					(b) Indian
Mysore State.					
Agricultural School, Hebbal	Three-year Course in English leading to an L. Ag. Diploma.	68	26	44	7
Vernacular Agricultural School, Chikkanahalli.	One-year Course . .	75	15	15	15
Vernacular Agricultural School, Hassan.	Ditto . .	22	15	11	**
Vernacular Agricultural School, Ramakrishnkrishisala.	Ditto . .	..	15	15	**
Baroda State.					
Agricultural School, Baroda	One-year Course . .	33	15	13	11
Travancore.					
Agricultural School, Alwaye	Two-year Course . .	25	16	16	12
Agricultural School, Kottara-Kara.	Ditto . .	95	29	39	22
Agricultural School, Koni .	Ditto . .	..	..	..	..
Patiala State.					
Bhupindra Agricultural School, Patiala.	Two year Course . .	19	19	11	**

** Examination not held.

in India during 1929-30 and 1930-31—contd.

1929-30				1930-31				Remarks.
Applications for admission	Admissions made during the year	Total number on the roll	Number passed in final examination	Applications for admission	Admissions made during the year	Total number on the roll	Number passed in final examination	
tural Schools—*contd.*								
84	15	14	13	49	13	8	8	
72	21	16	16	47	14	10	9	
..	42	54	70	..	43	79	12 20	
..	10	..	9	..	10	9	8	
..	64	..	64	..	27	..	27	
..	32	..	10	..	47	11	11	
..	10	..	10	..	14	..	7	
..	3	..	3	..	4	2	4	
..	3	..	1	..	14	14	14	
..	106	..	106	..	53	..	..	
..	6	..	1	..	10	..	..	
69	40	101	15	48	31	89	13	
States.								
96	28	59	5	102	30	72	12	
86	17	17	15	65	18	18	17	
30	17	11	11	21	17	11	8	
59	14	14	13	33	15	15	14	
59	15	10	10	51	15	9	9	
..	..	..	..	61	19	17	**	The last admission was in 1928.
..	..	..	..	52	32	29	**	Ditto.
..	..	..	..	138	52	52	**	Opened in 1931.
26	19	10	8	28	18	11	**	

APPENDIX IX.

Operations of Non-Credit Agricultural Co-operative Societies in British India during 1929-31.

The two tables below include Agricultural Societies for—

A. 1. *Purchase and Purchase and Sale.*—These are societies intended to facilitate the purchase of agricultural requisites for members, such as societies which purchase seed, manure, implements, etc., for sale to their members. Societies of this character which collect for joint sale the produce of members without making this their main object are also included in this class.

2. *Production.*—These are societies which have for their chief object an act of production without proposing to themselves sale as a direct object. These also include societies for joint irrigation, for collective use of machinery, for assistance in horse and cattle breeding, etc.

3. *Production and sale.*—This class includes societies in which these two functions are united or in which one or the other predominates, it being impossible to make a clear distinction between them. It covers all societies whose main object is the joint sale of any commodity, whether such commodity is produced or worked up or prepared for sale by the society itself or by the members individually. It comprises all co-operative creameries and distilleries, as well as societies whose main object is the sale of grain, cattle, eggs, *ghi*, etc., produced by their members.

4. Other forms of co-operation except insurance.

B. Insurance.

APPENDIX IX—*contd.*

Operations of Non-credit Agricultural Co-operative Societies in India during 1929-30 and 1930-31.

(A) PURCHASE, SALE AND PRODUCTION.

Province	Class of Societies	1929-30						
		Number of Societies	Number of Members	Sale of goods to Members	Purchase of members' products	Working Capital	Profit and loss for the year	REMARKS
				Rs.	Rs.	Rs.	Rs.	
Madras	Purchase and purchase and sale.	128	12,893	23,38,018	5,48,629	6,98,937	—4,859	
	Production and sale	42	2,047	..	..	1,75,089	—28,914	
	Others	391	24,032	..	..	4,20,592	—6,661	
	TOTAL	561	38,972	23,38,018	5,48,629	12,94,618	—40,434	
Bombay	Purchase and purchase and sale.	51	3,418	25,655	6,017	4,15,989	—7,552	
	Production	17	593	..	..	11,760	—318	
	Production and sale	81	15,142	9,98,901	3,62,621	15,08,461	+53,199	
	Others	104	59,146	61,515	10,652	3,39,331	+86,632	
	TOTAL	253	78,299	10,86,071	3,79,290	22,75,541	+1,31,961	

Operations of Non-credit Agricultural Co-operative Societies in India during 1929-30 and 1930-31—contd.

(A) PURCHASE, SALE AND PRODUCTION—*contd.*

Province	Class of Societies	1929-30						Remarks
		Number of Societies	Number of Members	Sale of goods to Members	Purchase of Members' Products	Working Capital	Profit and loss for the year	
				Rs.	Rs.	Rs.	Rs.	
Bengal	Purchase and purchase and sale.	108	31,606	77,13,193	79,94,917	48,26,012	—12,91,236	
	Production	887	22,626	65	..	4,25,687	—14,203	
	Production and sale	245	12,389	3,85,687	4,55,799	8,52,109	+1,22,873	
	Others	40	9,665	10,086	817	1,11,142	—50	
	TOTAL	1,280	76,286	81,09,031	84,51,533	62,14,950	—11,82,616	
United Provinces	Production and sale	23	454	..	19,939	261	+467	
	Others	117	3,722	..	..	1,682	+845	
	TOTAL	140	4,176	..	19,939	1,943	+1,312	
Punjab	Purchase and purchase and sale.	17	1,231	1,01,172	92,714	55,463	+3,631	
	Production	180	4,574	..	2	3,617	+786	
	Production and sale	805	42,640	27,05,463	33,57,434	7,33,200	+23,823	
	Others	83	1,533	..	..	68,073	+4,563	
	TOTAL	1,085	49,978	28,06,635	34,50,150	8,60,353	+32,803	

Burma.	Purchase and purchase and sale.	3	462	2,663	10,495	37,403	+16	
	Production	5	50	..	..	..	..	
	Production and sale	18	1,871	4,440	..	2,06,057	—75,418	
	TOTAL	26	2,383	7,103	10,495	2,43,460	—75,402	
Bihar and Orissa	Purchase and purchase and sale.	3	268	..	4,010	2,265	—411	
	Production	3	153	..	..	5,674	..	
	Production and sale	2	91	3	6	11,075	—49	
	Others	5	212	..	..	426	+65	
	Grain *Golas*	72	22,004	..	..	(*a*) 2,58,636	(*b*) +9,224	(*a*) And 83,652 mds. of grain.
	TOTAL	85	22,728	3	4,016	(*a*) 2,78,076	(*b*) +8,829	(*b*) And profit of 13, 742 mds. of grain.
Central Provinces	Purchase and purchase and sale.	26	1,399	3,04,817	..	1,34,495	+16,815	
	Production	4	43	..	100	456	..	
	Production and sale	7	775	21,370	..	83,964	+3,624	
	TOTAL	37	2,217	3,26,187	100	2,18,915	+20,439	
Assam	Production and sale	2	131	..	17,120	10,525	+3,656	
	TOTAL	2	131	..	17,120	10,525	+3,656	

Operations of Non-credit Agricultural Co-operative Societies in India during 1929-30 and 1930-31—contd.

(A) PURCHASE, SALE AND PRODUCTION—*contd.*

Province	Class of Societies	Number of Societies	Number of Members	Sale of goods to Members	Purchase of Members' Products	Working Capital	Profit and loss for the year	REMARKS
			1929-30					
				Rs.	Rs.	Rs.	Rs.	
Delhi	Cattle breeding	1	65	..	..	..	..	
	Consolidation of holdings	2	145	..	..	..	..	
	TOTAL	3	210	..	..	..	..	
Baroda State	Purchase and sale	..	..	..	..	..	..	
	Production	..	..	..	..	..	..	
	Production and sale	..	..	..	..	..	..	
	TOTAL	..	..	..	..	..	..	
Mysore	Purchase and purchase and sale	52	1,504	1,25,695	71,810	1,39,081	+5,417	
	Production	1	11	..	..	3,738	..	
	Production and sale	19	365	1,081	858	13,973	+393	
	TOTAL	72	1,880	1,26,776	72,668	156,792	+5,810	

1930-31

Madras	Purchase and purchase and sale.		12,914	3,38,019	4,32,138	4,53,475	—21,569
	Production and sale		1,791	..	..	1,61,765	—29,199
	Others	332	24,053	768	..	4,66,003	—10,564
	TOTAL	511	38,758	3,38,787	4,32,138	10,81,243	—61,332
Bombay	Purchase and purchase and sale.	44	3,918	29,991	19,932	3,75,143	—5,553
	Production	16	579	160	138	9,629	+134
	Production and sale	74	15,167	6,22,791	8,37,360	14,86,852	+90,814
	Others	105	51,254	52,264	1,242	4,70,578	+22,660
	TOTAL	239	70,918	7,05,206	8,58,672	23,42,202	+1,08,055
Bengal	Purchase and purchase and sale.	95	12,935	5,37,722	4,74,823	7,13,271	—65,586
	Production	929	23,747	227	18,385	4,49,605	—16,293
	Production and sale	267	13,331	3,74,718	7,64,962	9,76,001	—75,714
	Others	43	9,632	5,919	1,423	1,66,017	+3,491
	TOTAL	1,334	59,645	9,18,586	12,59,593	23,04,894	—1,54,102
United Provinces	Production and sale	31	805	44,923	49,811	8,426	+239
	Others	219	5,312	..	..	2,777	+497
	TOTAL	250	6,117	44,923	49,811	11,203	+736

Operations of Non-credit Agricultural Co-operative Societies in India during 1929-30 and 1930-31—contd.

(A) PURCHASE, SALE AND PRODUCTION—*contd.*

Province	Class of Societies	Number of Societies	Number of Members	Sale of goods to Members	Purchase of members' products	Working Capital	Profit and loss for the year	REMARKS.
				1930-31				
				Rs.	Rs.	Rs.	Rs.	
Puhjab . .	Purchase and purchase and sale.	18	1,489	1,16,510	1,04,998	69,633	—408	
	Production . . .	172	4,537	..	223	6,225	+346	
	Production and sale . .	954	55,295	22,35,271	24,14,910	7,19,035	+9,115	
	Others	88	1,670	..	..	72,700	+6,038	
	TOTAL .	1,232	62,991	23,51,781	25,20,131	8,67,593	+15,091	
Burma. . .	Purchase and purchase and sale.	12	823	..	219	37,338	—1,022	
	Production . . .	5	50	..	..	..	..	
	Production and sale . .	15	1,586	2,576	..	1,96,670	—69,833	
	TOTAL .	32	2,459	2,576	219	2,34,008	—79,855	
Bihar and Orissa .	Purchase and purchase and sale.	3	271	313	..	2,673	—465	
	Production . . .	3	161	..	..	8,009	—43	
	Production and sale . .	2	59	..	976	11,946	—332	

	Others	5	248	..	..	1,378	+91	
	Grain *Golas*	68	20,552	..	..	(c)2,04,419	+2,358(*d*)	(c) 128,257 mds. of grain.
	TOTAL	81	21,291	313	976	2,28,425	+1,609	(*d*) 21,308 mds. of grain.
Central Provinces	Purchase and purchase and sale.	30	1,413	69,081	..	2,47,791	+6,176	
	Production	4	44	..	..	456	..	
	Production and sale	8	832	6,162	..	50,291	+2,367	
	TOTAL	42	2,289	75,243	..	2,98,538	+8,543	
Assam	Production and sale	..	..	..	..	..	..	
	TOTAL	..	..	..	..	..	..	
Delhi	Cattle breeding	1	68	..	..	..	..	
	Consolidation of holdings	3	272	..	..	..	..	
	TOTAL	4	340	..	..	..	..	
Baroda State	Purchase and sale	21	669	22,484	1,076	6,804	664	
	Production	21	556	449	2,870	36,342	1,121	
	Production and sale	35	1,333	7,46,508	15,337	19,078	1,184	
	TOTAL	77	2,558	7,69,441	19,283	62,224	2,969	
Mysore	Purchase and purchase and sale.	49	1,449	18,839	553	1,54,123	+2,815	
	Production	1	13	..	..	3,612	..	Not working.
	Production and sale	18	380	2,552	1,766	14,371	+1,570	
	TOTAL	68	1,842	21,391	2,319	1,72,106	4,385	

Operations of Non-credit Agricultural Co-operative Societies in India during 1929-30 and 1930-31—contd.

(B) CATTLE INSURANCE.

Province	Number of societies	Amount of risk insured	Premia collected during the year	Supplementary contributions collected	Number of animals		Claims paid	Cost of management	Funds in hand at the end of the year	Amount of risk re-insured	Amount of premia paid for re-insurance
					Insured	Lost					
		Rs.	Rs.	Rs.			Rs.	Rs.	Rs.	Rs.	Rs.
1929-30											
Bombay	3	5,025	251	..	78	5	154	79	1,439	..	..
Madras	5	..	..	..	..	..	..	..	61	..	..
Burma	257	6,695	150	..	129	3	108	78	20,711	3,347	75
	1*	11,535	130	..	234	6	62	795	15,540	..	..
1930-31											
Bombay	1	4,370	219	..	73	7	313	109	989	..	..
Madras	5	..	..	..	..	..	..	..	61	..	..
Burma	..	..	..	..	..	..	..	..	..	..	..

* Central Re-insurance Society.

APPENDIX X.

Showing the working of the Veterinary Departments in India during 1929-30 and 1930-31.

Province	1929-30											
	Reported mortality from contagious diseases			Dispensaries and hospitals.			District work					
	Rinderpest	Other diseases	Total	Number of institutions	Cases treated	Castrations performed	Cases treated	Castrations performed	Outbreaks in which inoculation was undertaken	Deaths uninoculated	Inoculations*	Deaths after inoculation
					(*a*) British India.							
Madras	106,046	52,600	158,646	115	157,616	6,549	54,420	6,193	1,910	44,818	196,607	761
Bombay	14,892	9,260	24,152	106	207,683	19,131	66,043	9,152	1,110	13,482	157,149	244
Bengal	10,183	5,750	15,933	46	79,358	90	129,316	90	715	9,623	144,730	762
United Provinces	35,845	12,486	48,331	165	295,840	2,878	100,883	369	1,777	21,646	220,786	261
Punjab	10,631	13,651	24,282	270	1,060,516	185,177	304,212	179,014	1,002	7,823	476,406	187
Burma	6,472	2,855	9,327	5	15,458	16	105,365	70	528	4,695	72,038	726
Bihar and Orissa	27,212	8,482	35,694	33	74,135	7,553	113,163	64,374	1,789	12,975	324,032	1,259
Central Provinces	36,022	10,019	46,041	99	292,385	7,624	407,058	61,829	2,684	17,794	374,664	289
Assam	20,536	13,452	33,988	3	4,367	117	86,657	7,102	504	18,595	42,331	785
North-West Frontier Province	526	962	1,488	19	78,853	13,142	40,773	25,054	44	545	11,378	12
Sind	2,588	6,623	9,211	18	28,994	1,157	5,093	366	92	11,146	5,143	27
Baluchistan	4	13,316	13,320	10	21,348	115	67,932	15	3	147	515	..
Rajputana	647	118	765	2	3,532	13	83	..	9	250	741	1
Total	271,604	149,574	421,178	891	2,320,085	243,562	1,480,998	353,628	12,167	163,539	2,026,520	5,314
Total for 1928-29	237,441	134,375	371,816	863	2,145,201	206,941	1,266,731	303,958	11,237	115,757	1,899,428	4,768
					(*b*) Indian States.							
Mysore	8,590	16,184	24,774	57	250,899	12,717	29,213	29,649	7,509	..	237,812	..
Hyderabad	6,145	2,740	8,845	76	153,907	..	59,452	2,299	145	2,249	27,826	79

Showing the working of the Veterinary Departments in India during 1929-30 and 1930-31—contd.

Province	1930-31											
	Reported mortality from contagious diseases			Dispensaries and Hospitals			District work					
	Rinderpest	Other diseases	Total	Number of institutions	Cases treated	Castrations performed	Cases treated	Castrations performed	Outbreaks in which inoculation was undertaken	Deaths uninoculated	Inoculations*	Deaths after inoculations
						(*a*) British India.						
Madras	59,323	40,658	99,981	122	176,053	8,312	56,541	15,175	1,666	34,803	175,847	507
Bombay	28,187	6,665	34,852	106	215,788	24,481	28,941	12,360	1,506	19,797	202,328	342
Bengal	9,345	3,664	13,009	48	94,901	134	136,747	210	462	8,166	90,069	482
United Provinces	25,919	11,837	37,756	166	315,026	10,600	87,272	5,930	1,743	15,964	193,630	187
Punjab	6,142	11,486	17,628	287	1,173,042	202,817	289,008	187,605	930	7,054	450,483*	177
Burma	7,013	2,886	9,899	5	14,662	16	120,367	61	708	4,121	81,179*	575
Bihar and Orissa	28,541	5,188	33,729	126	76,903	11,549	137,170	67,694	487	4,570	79,641	549
Central Provinces	12,144	5,832	17,976	100	270,963	9,810	294,439	82,776	1,378	7,874	229,177	142
Assam	16,442	13,417	29,859	3	4,656	299	87,427	12,233	341	8,990	24,236	509
North-West Frontier Province	90	1,106	1,196	19	84,887	15,142	56,660	30,530	39	242	8,334	..
Sind	10,455	2,920	13,375	18	28,938	1,633	3,712	435	133	2,950	12,991	98
Baluchistan	..	7,479	7,479	10	25,079	165	57,284	117	5	400	289	..
Rajputana	157	14	171	2	4,491	10	309†	..	5	126	778	..
Total	203,758	113,152	316,910	1,012	2,485,389	284,968	1,355,877	415,126	9,403	115,057	1,548,982	3,568
Total for 1929-30	271,604	149,574	421,178	891	2,320,085	243,562	1,480,998	353,628	12,167	163,539	2,026,520	5,314
Mysore	4,239	18,306	22,545	60	168,206	17,264	39,903	43,504	962	8,181	208,679	405
Hyderabad	18,866	1,654	20,520	76	193,406	..	59,407	10,672	423	12,782	94,158	48

* Includes vaccinations also. † Includes castrations also.

APPENDIX XI.

Showing the working of the Veterinary Colleges and Schools in India during 1929-30 and 1930-31.

Veterinary College or School	Course of instruction.	1929-30.								
		Number of Students						Students admitted during the year classed by educational qualifications		
		Admitted during the year		Passed final examination during the year	Failed to pass final examination	Remaining under instruction at end of the year		Matriculates, school finals or with higher qualifications	Knowing some English but not matriculates	Knowing no English or very little English
		Scholarship holders	Others			In ordinary course	Instruction prolonged by reason of failure to pass			
Madras Veterinary College	3 years course	40	16	19	7	59	22	56	..	..
	Refresher course	7		7*	..	..	..	..	..	..
Bombay Veterinary College	Veterinary Science	8	56	24	5	108	22	58	6	..
Bengal Veterinary College	3 years course	30	19	40	20	77	46	42	7	..
Punjab Veterinary College	4 years course	61		16	..	189	..	61	..	..
	Post Refresher course.	3		1	..	3	..	..	..	..
Insein Veterinary School	3 years vernacular course.	..	..	13	..	..	..	..	..	..

* All granted certificates.

Showing the working of the Veterinary Colleges and Schools in India during 1929-30 and 1930-31—concld.

Veterinary College or School	Course of instruction	1930-31.								
		Number of students						Students admitted during the year classed by educational qualifications		
		Admitted during the year		Passed final examination during the year	Failed to pass final examination	Remaining under instruction at the end of the year		Matriculates, School finals or with higher qualifications	Knowing some English but not matriculates	Knowing no English or very little English
		Scholarship holders	Others			In ordinary course	Instruction prolonged by reason of failure to pass			
Madras Veterinary College	3 years course	20	32	27	5	60	26	52	..	..
	Refresher course	8		8*	..	..	..	..	..	..
Bombay Veterinary College	Veterinary science	11	39	19	7	115	22	50	..	..
Bengal Veterinary College	3 years course	34	24	34	15	72	31	119	22	..
Punjab Veterinary College	4 years course	22	14	38	13	166	26	36	..	..
	Post Refresher course.	5	..	3	..	..	..	..	..	..
Insein Veterinary School	3 years vernacular course.	..	..	..	..	..	..	..	..	..
Bihar and Orissa Veterinary College.	3 years course	47†	5	10	5	24	15	50	2	..

* All granted certificates. † Includes students transferred from Bengal Veterinary College.

APPENDIX XII.

Showing the number of cattle issued from Government Farms during 1929-31.

Province	Bulls	Cows	Male buffaloes	She buffaloes	Young stock	Total for 1929-30	Bulls	Cows	Male buffaloes	She buffaloes	Young stock	Total for 1930-31	Total for 1928-29
Madras . . .	44	43	6	4	23	120	51	39	11	3	20	124	156
Bombay . . .	39	32	..	..	27	98	42	30	..	..	47	119	204
Bengal . . .	..	18	..	..	..	18	10	..	..	..	..	10	14
United Provinces .	468	..	100	..	..	568	298	..	330	..	..	611	779
Punjab . . .	335	1	..	..	2	338	295	..	..	..	..	295	436
Bihar and Orissa .	4	34	37	3	44	122	..	44	12	..	97	153	158
Central Provinces .	28	71	..	1	91	191	27	23	1	8	36	95	222
Assam . . .	21	9	..	..	7	37	9	33	..	..	13	55	29
North-West Frontier Province.	..	..	..	..	..	50	2	3	..	..	6	11	5
Sind	..	..	..	..	..	11	12	12	..	..	22	46	..
Imperial Farms.													
Pusa	1	13	..	..	76	90	1	52	..	..	110	163	72
Karnal . . .	..	31	..	1	14	46	..	40	1	..	116	157	102
Bangalore . . .	1	26	..	1	61	89	2	28	..	3	43	76	54
Wellington . .	1	19	..	..	18	38	2	5	..	..	47	54	12

APPENDIX XIII.

List of Agricultural Publications in India during 1929-31.

No.	Title	Author	Where published
	GENERAL AGRICULTURE		
1	*The Agricultural Journal of India*, Vol. XXIV, Parts IV, V and VI. Price, Re. 1-8 or 2*s.* per part. Annual subscription Rs. 6 or 9*s.* 9*d.*	Edited by the Agricultural Adviser to the Government of India.	Manager of Publications, Civil Lines, Delhi.
2	*The Agricultural Journal of India*, Vol. XXV, Parts I, II, III, IV, V and VI. Price, Re. 1-8 or 2*s.* per part. Annual subscription, Rs. 6 or 9*s.* 9*d.*	Issued under the authority of the Imperial Council of Agricultural Research.	Ditto.
3	*Agriculture and Live-stock in India*, Vol. I, Parts I, II and III. Price, Re. 1-8 or 2*s.* 6*d.* per part. Annual subscription, Rs. 6 or 9*s.* 9*d.*	Ditto	Ditto.
4	*The Journal of the Mysore Agricultural and Experimental Union* (Quarterly). Annual subscription, Rs. 3.	B. Narashinha Iyengar	Bangalore Press, Bangalore.
5	*The Madras Agricultural Journal* (Monthly). Annual subscription, Rs. 4; single copy, As. 6.	T. V. Ramakrishna Ayyar	The Scholar Press, Palghat.
6	*Poona Agricultural College Magazine* (Quarterly). Annual subscription, Rs. 2-8; single copy, As. 10.	V. G. Deshpande and S. M. Rao.	Aryabhushan Press, Poona City.
7	*The Nagpur Agricultural College Magazine* (Quarterly). Annual subscription, Rs. 3.	P. D. Nair	The Huxley Press, Madras.
8	*The Allahabad Farmer* (Quarterly). Single copy, As. 8. (Per year Rs. 2).	W. B. Hayes	The Mission Press, Allahabad.
9	*Quarterly Journal of the Indian Tea Association.* Price As. 6 per copy.	Scientific Department of the Indian Tea Association, Calcutta.	Catholic Orphan Press, Calcutta.
10	*The Planters' Chronicle* (Weekly). Price, As. 8 per copy.	F. E. James	Diocesan Press, Post Box 455, Madras.

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE—*contd.*		
11	*Rural India* (Monthly). Single copy As. 6. Annual subscription, Rs. 3.	A. Swaminatha Aiyer .	Magazine Press, Chingleput.
12	*Journal of the Trichinopoly Agricultural Association* (Quarterly). Annual subscription, Rs. 1-8 for non-members, free for members.	Issued by the Trichinopoly District , Agricultural Association.	Sri Nilayam Press, Trichinopoly.
13	Scientific Reports of the Agricultural Research Institute, Pusa (including the Reports of the Imperial Dairy Expert, Physiological Chemist, Government Sugarcane Expert, and Secretary, Sugar Bureau) for the year 1928-29. Price, Rs. 2-8 or 4*s.* 6*d.*	Issued by the Imperial Institute of Agricultural Research, Pusa.	Manager of Publications, Civil Lines, Delhi.
14	Scientific Reports of the Imperial Institute of Agricultural Research, Pusa (including the Reports of the Imperial Dairy Expert, Physiological Chemist, Government Sugarcane Expert and Secretary, Sugar Bureau) for the year 1929-30. Price, Rs. 3-8 or 6*s.*	Ditto .	Ditto.
15	Review of Agricultural Operations in India, 1928-29. Price, Rs. 3-2 or 5*s.* 6*d.*	Issued by the Imperial Council of Agricultural Research.	Ditto.
16	Proceedings of the Board of Agriculture in India, held at Pusa on the 9th December 1929 and following days (with Appendices). Price, Rs. 3-10 or 6*s* 3*d.*	Issued by the Government of India.	Ditto.
17	Annual Report of the Indian Central Cotton Committee, Bombay, 1929. Price Rs. 2.	J. H. Ritchie . .	G. Claridge & Co., Bombay.
18	Annual Report of the Indian Central Cotton Committee, Bombay, 1930. Price, Rs. 2.	Ditto .	Ditto.
19	Report on the Operations of the Department of Agriculture, Madras Presidency for the year 1928-29.	Issued by the Department of Agriculture, Madras.	Government Press, Madras.

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE—*contd.*		
20	Report on the Operations of the Department of Agriculture, Madras Presidency for the year 1929-30.	Issued by the Department of Agriculture, Madras.	Government Press, Madras.
21	Villagers' Calendar, 1929 and 1930 (English).	Ditto .	Ditto.
22	Villagers' Calendar for 1929-30 (Tamil, Telugu, Kanarese and Malayalam).	Ditto .	Ditto.
23	Villagers' Calendar for 1930-31 Kanarese, Telugu, Tamil and Malayalam).	Ditto .	Ditto.
24	Care and management of cattle manure in South India. (Madras Department of Agriculture Leaflet No. 24. English, Tamil, Telugu, Malayalam and Kanarese).	V. Muthuswami Ayyar .	Ditto.
25	Green manuring. (Madras Department of Agriculture Leaflet No. 25. English, Tamil, Telugu, Malayalam and Kanarese).	B. Ramiah . . .	Ditto.
26	Revised Note on tapioca. (Madras Department of Agriculture Leaflet No. 26. English, Tamil, Telugu, Malayalam and Kanarese).	K. Unnikrishna Menon .	Ditto.
27	Telugu songs on improved method of paddy cultivation. (Madras Department of Agriculture Leaflet No. 27. Telugu)	D. Balakrishnamurthi .	Ditto.
28	Weeds—weeds—weeds. (Madras Departm[illegible] of Agriculture Leaflet No. 28. English, Tamil, Telugu, Kanarese and Malayalam).	D. T. Chadwick . .	Ditto.
29	The Sindhewabe furnace for Jaggery manufacture. (Madras Department of Agriculture Leaflet No. 29. English, Tamil, Telugu, Kanarese and Malayalam).	C. Narayana Ayyar .	Ditto.
30	Pure cotton. (Madras Department of Agriculture Leaflet No. 33. English and Tamil).	B. Ramiah . . .	Ditto.

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE—*contd.*		
31	The Improvement of Sugarcane seed (English and Telugu). Madras Department of Agriculture Leaflet No. 58.	A. C. Edmunds . .	Government Press, Madras.
32	The Production of Fodder and Green Manure seeds (English and Telugu). Madras Department of Agriculture Leaflet No. 59.	Ditto . .	Ditto.
33	Broad Hints for every-day use (English). Madras Department of Agriculture Leaflet No. 64.	G. R. Hilson . . .	Ditto.
34	Potatoes (English, Telugu, Tamil, Malayalam and Kanarese). Madras Department of Agriculture Leaflet No. 65.	F. H. Butcher . .	Ditto.
35	Note on Turmeric (English, Telugu, Tamil, Malayalam and Kanarese). Madras Department of Agriculture Leaflet No. 67.	Issued by the Department of Agriculture, Madras.	Ditto.
36	School Garden (English, Tamil, Telugu, Kanarese and Malayalam). Madras Department of Agriculture Leaflet No. 68.	Ditto .	Ditto.
37	Water rate or Fasalijasti for certain crops-concession made by Government to ryots in aid of cultivation (English, Telugu, Tamil, Kanarese and Malayalam). Madras Department of Agriculture Leaflet No. 69.	Ditto .	Ditto.
38	How to send specimens (English, Tamil, Telugu and Malayalam). Madras Department of Agriculture Leaflet No. 71 and 71(*a*).	S. R. Srinivasa Iyengar .	Ditto.
39	Planting of Trees. Standing Order of the Board of Revenue, Land Revenue and Settlement (English, Malayalam, Telugu and Tamil). Madras Department of Agriculture Leaflet No. 73.	Issued by the Department of Agriculture, Madras.	Ditto.

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE—*contd.*		
40	Loan to ryots (English, Telugu, Tamil, Kanarese and Malayalam). Madras Department of Agriculture Leaflet No. 74.	Issued by the Department of Agriculture, Madras.	Government Press, Madras.
41	Results of Demonstrations of Agricultural Improvements in the Madras Circle carried out in 1924-27. Madras Department of Agriculture Bulletin No. 97.	D. Ananda Rao . .	Ditto.
42	Pepper cultivation in the West Coast (English, Malayalam and Kanarese). Madras Department of Agriculture Bulletin No. 98.	M. Govinda Kidavu and P. A. Venkateswaram.	Ditto.
43	Results of Experiments at Samalkota in Intermediate Season Cropping. Madras Department of Agriculture Bulletin No. 99.	A. C. Edmunds and G. Jogiraju.	Ditto.
44	Results of Experiments conducted at the Agricultural Research Station, Palur (English). Madras Department of Agriculture Pamphlet No. 2.	D. Ananda Rao and A. Ramaswami Ayyar.	Ditto.
45	Notes on the result of chemical, entomological and mycological experiments conducted at the Research Station, Vallalur, during 1925-30. Madras Department of Agriculture Pamphlet No. 3 (English, Tamil, Telugu, Malayalam and Kanarese).	B. Viswanath, Y. Ramachandra Rao and S. Sundararama Ayyar.	Ditto.
46	Digest of the Operations of the Department of Agriculture, Madras, for quarter ending 31st March 1930 (English, Tamil, Telugu and Malayalam). Madras Department of Agriculture Digest No. 87.	D. Ananda Rao . .	Ditto.
47	Digest of the Operations of the Department of Agriculture, Madras, for quarter ending 30th June 1930 (English, Tamil, Telugu and Malayalam). Madras Department of Agriculture Digest No. 88.	Ditto . .	Ditto.

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE—*contd.*		
48	Digest of the Operations of the Department of Agriculture, Madras, for quarter ending 30th September 1930 (English, Tamil, Telugu, Malayalam and Kanarese). Madras Department of Agriculture Digest No. 89.	D. Anando Rao . .	Government Press, Madras.
49	Digest of the Operations of the Department of Agriculture, Madras, for the quarter ending 30th December 1930. Madras Department of Agriculture Digest No. 90 (English, Tamil, Telugu, Malayalam and Kanarese).	Ditto .	Ditto.
50	Digest of the operations of the Department of Agriculture, Madras, for the quarter ending 31st March 1931. Madras Department of Agriculture Digest No. 91. (English, Tamil, Telugu, Malayalam and Kanarese).	Ditto . .	Ditto.
51	Broad Hints for every-day use, No. 1 (English, Telugu, Tamil. Malayalam and Kanarese).	G. R. Hilson . . .	Ditto.
52	Plough early. (English, Tamil, Telugu, Malayalam and Kanarese). Madras Department of Agriculture Broad Hints for every-day use, No. III	D. Ananda Rao . .	Ditto.
53	Plough efficiently. (English, Tamil, Telugu and Kanarese). Madras Department of Agriculture Broad Hints for every-day use, No. IV.	Ditto . .	Ditto.
54	Sow good seed. (English, Tamil, Telegu and Kanarese). Madras Department of Agriculture Broad Hints for every-day use, No. V.	G. R. Hilson . . .	Ditto.
55	Beware of weeds. (English, Telugu, Malayalam and Kanarese). Madras Department of Agriculture Broad Hints for every-day use, No. VI.	Ditto . .	Ditto.

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE—*contd.*		
56	Note on Pure Paddy Seed, VIII Circle. (English and Tamil). Madras Department of Agriculture Note No. 1.	R. C. Broadfoot . .	Government Press, Madras.
57	Note on Pure Paddy Seed, I Circle. (English and Telugu). Madras Department of Agriculture Note No. 2.	A. C. Edmunds . .	Ditto.
58	Note on Pure Paddy Seed, VI Circle. (English and Tamil). Madras Department of Agriculture Note No. 3.	B. Ramiah . . .	Ditto.
59	Some suggestions to the ryots of the IV Circle to obtain and keep paddy seed pure. (English, Tamil and Telugu). Madras Department of Agriculture Notes No. 4.	M. Govinda Kidavu .	Ditto.
60	Annual Report of the Department of Agriculture in the Bombay Presidency for the year 1928-29.	Issued by the Department of Agriculture, Bombay.	Government Press, Bombay.
61	Annual Report of the Department of Agriculture in the Bombay Presidency for the year 1929-30.	Ditto. .	Ditto.
62	Useful hints for the cultivation of groundnut (Guzarati). Bombay Department of Agriculture Leaflet No. 3 of 1930.	Ditto .	Ditto.
63	Important hints to growers of Banilla Cotton (Marathi). Bombay Department of Agriculture Leaflet No. 4 of 1930.	Ditto .	Ditto.
64	Reclamation of salt lands in the Gokak canal tract. Bombay Department of Agriculture Leaflet No. 5 of 1930.	Ditto .	Ditto,
65	Economic manures for garden crops in the North Konkan. Bombay Department of Agriculture Leaflet No. 8 of 1930.	Ditto .	Ditto.

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE—*contd.*		
66	Risks associated with the practice of suspense sales of seed—cotton and advice upon how to pack seed—cotton in carts (Marathi). Bombay Department of Agriculture Leaflet No. 10 of 1930.	Issued by the Department of Agriculture, Bombay.	Government Press Bombay.
67	Rabi cultivation of chillies in the Konkan. Bombay Department of Agriculture Leaflet No. 11 of 1930.	Ditto .	Ditto.
68	Study in intensive farming near Poona under canal irrigation. Bombay Department of Agriculture Bulletin No. 164 of 1930.	B. S. Patel and H. M. Desai	Ditto.
69	Frost of January 1929 and its damage to crops of the Bombay Presidency. Bombay Department of Agriculture Bulletin No. 165 of 1930. Price, As. 6.	K. V. Joshi . . .	Ditto.
70	Annual Reportof the Department of Agriculture, Bengal, 1928-29.	Issued by the Department of Agriculture, Bengal.	Bengal Secretariat Book Depôt, Calcutta.
71	Annual Report of the Department of Agriculture, Bengal, 1929-30. Price, Rs. 4-5 or 7*s*.	Ditto .	Ditto.
72	Artificial fertilizers. Bengal Department of Agriculture Leaflet No. 4 of 1929.	Ditto .	Ditto.
73	Cultivation of English Vegetables. Bengal Department of Agriculture Leaflet No. 5 of 1929.	Ditto .	Ditto.
74	Tobacco in Bengal. Bengal Department of Agriculture Leaflet No. 6 of 1929.	Ditto .	Ditto.
75	Notes on crops which can be substituted for jute. (English and Bengali). Bengal Department of Agriculture Leaflet No. 7 of 1929.	Ditto .	Ditto.
76	Notes on why fodder crops should be substituted for jute and paddy (English and Bengali). Bengal Department of Agriculture Leaflet No. 1 of 1931.	Ditto .	Ditto.

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE—*contd.*		
77	Dudsar paddy (English and Bengali). Bengal Department of Agriculture Leaflet No. 3 of 1931.	Issued by the Department of Agriculture, Bengal.	Bengal Secretariat Book Depôt, Calcutta.
78	Notes on improved method of Agriculture for Bengal with improved implements specially designed and locally constructed to suit the soils, the cattle and the pocket of the Bengali cultivator (English and Bengali). Leaflet No. 4 of 1931 of the Department of Agriculture, Bengal.	Ditto	Ditto.
79	Improved ploughs for the use of the Bengal cultivators.	Ditto	Ditto.
80	Report on the Administration of the Department of Agriculture, United Provinces, for the year ending 30th June 1929.	Issued by the Department of Agriculture, United Provinces.	Government Press, Allahabad.
81	Report on the Administration of the Department of Agriculture, United Provinces, for the year ending 30th June 1930.	Ditto	Ditto.
82	Report on the Agricultural Stations of the Central Circle, Cawnpore, United Provinces, for the year ending June 30, 1929.	Ditto	Ditto.
83	Report on the Agricultural Stations of the Central Circle, Cawnpore, United Provinces, for the year ending June 30, 1930.	Ditto	Ditto.
84	Report on the Agricultural Stations of the Western Circle, Aligarh, United Provinces, for the year ending June 30, 1929.	Ditto	Ditto.
85	Report on the Agricultural Stations of the Western Circle, Aligarh, United Provinces, for the year ending June 30, 1930.	Ditto	Ditto.
86	Combined Report on the Experimental Stations in Eastern Circle, Partabgarh, United Provinces, for the year ending May 31, 1929.	Ditto	Ditto.

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE—*contd.*		
87	Combined Report on the Experimental Stations in Eastern Circle, Partabgarh, United Provinces, for the year ending May 31, 1930.	Issued by the Department of Agriculture, United Provinces.	Government Press, Allahabad.
88	Report on the Agricultural Stations of the North-Western Circle, Gorakhpur, United Provinces, for the year ending June 30, 1929.	Ditto	Ditto.
89	Report on the Agricultural Stations of the North-Eastern Circle, Gorakhpur, United Provinces, for the year ending June 30, 1930.	Ditto	Ditto.
90	Report on the Agricultural Stations in the Rohilkhand Circle, Shahjahanpur, United Provinces, for the year ending June 30, 1929.	Ditto	Ditto.
91	Report on the Agricultural Stations in the Rohilkhand Circle, Shahjahanpur, United Provinces, for the year ending June 30, 1930.	Ditto	Ditto.
92	Report on the Agricultural Stations of the Bundelkhand Circle, United Provinces, for the year ending June 30, 1929.	Ditto	Ditto.
93	Report on the Agricultural Stations of the Bundelkhand Circle, United Provinces, for the year ending June 30, 1930.	Ditto	Ditto.
94	Report on the Agricultural Stations in the Hill Circle, United Provinces, for the year ending June 30, 1929.	Ditto	Ditto.
95	Report on the Agricultural Stations in the Hill Circle, United Provinces, for the year ending June 30, 1930.	Ditto	Ditto.
96	Report on the Working and Administration of the United Provinces, Government Gardens for the year 1928-29.	Ditto	Ditto.

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE—*contd.*		
97	Report on the Working and Administration of the United Provinces Gardens for the year 1929-30.	Issued by the Department of Agriculture, United Previnces.	Government Press, Allahabad.
98	Introduction of Long Staple Cotton in the United Provinces, its past, present and future.	B. Ram Prasad . .	Ditto.
99	Bulletin No. 50 of the Department of Agriculture, United Provinces.	Jai Krishna Mathur .	Ditto.
100	Organisation of Wheat Trade in N.-W. Region. Bulletin No. 51 of the Department of Agriculture, United Provinces.	Tiryngi Prasad . .	Ditto.
101	Economic survey of a village in Cawnpore. Bulletin No. 52 of the Department of Agriculture, United Provinces.	Ram Misra . . .	Ditto.
102	Experiments in Electric Farming. Bulletin No. 53 of the Department of Agriculture, United Provinces.	S. S. Nehru . . .	Ditto.
103	Dynamometer tests and efficiency of some Improved Ploughs. Bulletin No. 54 of the Department of Agriculture, United Provinces.	C. Maya Das . .	Ditto.
104	A brochure of School Gardens. Bulletin No. 55 of the Department of Agriculture, United Provinces. (Revised edition).	Issued by the Department of Agriculture, United Provinces.	Ditto.
105	The Farm Tractor in India. Bulletin No. 56 of the Department of Agriculture, United Provinces.	C. Maya Das . .	Ditto.
106	Report on Cotton Purchase Operations, 1929-30 and 1930-31. Bulletin No. 57 of the Department of Agriculture, United Provinces.	Issued by the Department of Agriculture, United Provinces.	Ditto.
107	C. 402, a new variety of Long Staple cotton in the United Provinces. Bulletin No. 58 of the Department of Agriculture, United Provinces.	Ram Prasad . .	Ditto.

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE—*contd.*		
108	Studies in Agricultural Improvement.	C. Maya Das . .	Government Press, Allahabad.
109	Report on the Operations of the Department of Agriculture, Punjab, for the year ending June 30, 1929. Part I, Price Rs. 1-6, Part II, Vol. I. Price, Rs. 6 and Vol. II. Price, Rs. 20.	Issued by the Department of Agriculture, Punjab.	Government Printing, Lahore.
110	Annual Report of the Department of Agriculture, Punjab, for the year ending June 30, 1930. Part I. Price, Re. 1-6 or 2*s*. 2*d*. per copy.	Ditto .	Ditto.
111	*Seasonal Notes of the Punjab Department of Agriculture* (Half-yearly). Price, per issue, As. 4.	Ditto .	Ditto.
112	A note of 289-F. American Cotton for farmers. Punjab Department of Agriculture Leaflet No. 74.	Ditto .	Ditto.
113	Some hints for making a lawn. Punjab Department of Agriculture Leaflet No. 75.	Ditto .	Ditto.
114	Sugarcane crushing. Punjab Department of Agriculture Leaflet No. 76.	Ditto .	Ditto.
115	Damping of cotton. Punjab Department of Agriculture Leaflet No. 80.	Ditto .	Ditto.
116	Information regarding Boring of Wells by the Agricultural Department, Punjab. Punjab Department of Agriculture Leaflet No. 84.	Ditto .	Ditto.
117	Hints on cotton cultivation. Punjab Department of Agriculture Leaflet No. 86.	Ditto .	Ditto.
118	How to succeed with berseem. Punjab Department of Agriculture Leaflet No. 90.	Ditto .	Ditto.
119	Reclamation of Kalar Soils. Punjab Department of Agriculture Leaflet No. 91.	Ditto .	Ditto.

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE—*contd.*		
120	Methods of Legume inoculation. Punjab Department of Agriculture Leaflet No. 92.	Issued by the Department of Agriculture, Punjab.	Government Printing, Lahore.
121	Rule for the Control of well borers.	Ditto	Ditto.
122	Guide to the Punjab Agricultural College and Research Institute, Lyallpur.	Ditto	Ditto.
123	Enquiries regarding Indian oil-seed crops. Price, As. 9.	K. S. Ch. Ali Mohammad	Ditto.
124	Prospectus of the Punjab Agricultural College, Lyallpur. Price, As. 4.	Issued by the Department of Agriculture, Punjab.	Ditto.
125	Potato crop and its improvement in the Punjab. Price, As. 6.	D. Milne and K. S. Ch. Ali Mohammad.	Ditto.
126	Enquiries regarding Indian oil-seed crops (Urdu). Price, Annas 5 per copy.	K. S. Ch. Ali Mohammad	Ditto.
127	Annual Report on the Operations of the Department of Agriculture, Burma, for the year ending 30th June, 1929. Price, Re. 1-8 or 2*s.* 3*d.*	Issued by the Department of Agriculture, Burma.	Government Printing, Burma, Rangoon.
128	Annual Report on the Operations of the Department of Agriculture, Burma, for the year ending 30th June, 1930.	Ditto	Ditto.
129	Annual Report of the Principal, Agricultural College and Research Institute, Burma, Mandalay, for the year ending 30th June, 1929.	Ditto	Ditto.
130	Annual Report of the Principal, Agricultural College, and Research Institute, Burma, Mandalay, for the year ending 30th June, 1930.	Ditto	Ditto.
131	Report on the Hmawbi Agricultural Station, for the year ending 30th June, 1929.	Ditto	Ditto.
132	Report on the Hmawbi Agricultural Station, for the year ending 30th June, 1930.	Ditto	Ditto.

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE—*contd.*		
133	Report on the Mudon Agricultural Station, for the year ending 30th June, 1929.	Issued by the Department of Agriculture, Burma.	Government, Printing, Burma, Rangoon.
134	Report on the Mudon Agricultural Station, for the year ending 30th June, 1930. Price, Re. 1 or 1*s.* 6*d.*	Ditto .	Ditto.
135	Report on the Mahlaing Experimental Station, for the year ending 30th June, 1929.	Ditto .	Ditto.
136	Report on the Mahlaing Experimental Station, for the year ending 30th June, 1930.	Ditto .	Ditto.
137	Report on the Pwinbyu Seed Farm, for the year ending 30th June, 1929.	Ditto .	Ditto.
138	Report on the Pwinbyu Seed Farm, for the year ending 30th June, 1930.	Ditto .	Ditto.
139	Report on the Pyinmana Agricultural Station, for the year ending 30th June, 1929.	Ditto .	Ditto.
140	Report on the Pyinmana Agricultural Station for the year ending 30th June, 1930.	Ditto .	Ditto.
141	Report on the Yaunghwe Agricultural Station and Agricultural work in the Southern Shan States, for the year ending 30th June, 1929.	Ditto .	Ditto.
142	Report on the Yaunghwe Agricultural Station and Agricultural Work in the Southern Shan States, for the year ending 30th June, 1930.	Ditto .	Ditto.
143	The combined report on the Akyab Agricultural Station and Kyaukpyau coconut farm for the year ending 30th June, 1929. Price, As. 12 or 1*s.* 1*d.*	Ditto .	Ditto.
144	The combined report on the Akyab Agricultural Station and Kyaukpyau coconut farm for the year ending 30th June, 1930. Price, As. 12 or 1*s.* 1*d.*	Ditto .	Ditto.

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE—*contd.*		
145	Report on the Myaungmya Agricultural Station, for the year ending 30th June, 1929.	Issued by the Department of Agriculture, Burma.	Government Printing, Burma, Rangoon.
146	Report on the Myaungmya Agricultural Station, for the year ending 30th June, 1930.	Ditto .	Ditto.
147	Report on the Padu Agricultural Station, for the year ending 30th June, 1929.	Ditto .	Ditto.
148	Report on the Padu Agricultural Station for the year ending 30th June, 1930.	Ditto .	Ditto.
149	Report on the Allanmyo Agricultural Station, for the year ending 30th June, 1929.	Ditto .	Ditto.
150	Report on the Allanmyo Agricultural Station, for the year ending 30th June, 1930.	Ditto .	Ditto.
151	Report on the Mandalay Agricultural College Farm, for the year ending 30th June, 1929.	Ditto .	Ditto.
152	Report on the Mandalay Agricultural College Farm, for the year ending 30th June, 1930.	Ditto .	Ditto.
153	Report on the Tatkon Agricultural Station, for the year ending 30th June, 1929.	Ditto .	Ditto.
154	Report on the Tatkon Agricultural Station, for the year ending 30th June, 1930.	Ditto .	Ditto.
155	Report on the Sa-aing Sub-station for the year ending 30th June, 1929.	Ditto .	Ditto.
156	Report on the Sa-aing Sub-station, for the year ending 30th June, 1930. Price, As. 2 or 2*d.*	Ditto .	Ditto.
157	Report of the Agricultural Engineer, Burma, for the year ending 30th June, 1929.	Ditto .	Ditto.
158	Report of the Agricultural Engineer, Burma, for the year ending 30th June, 1930.	Ditto .	Ditto.

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE—*contd.*		
159	Agricultural Calendar, Burma .	Issued by the Department of Agriculture, Burma.	Government Printing, Burma, Rangoon.
160	Instructions for testing Agricultural seeds. Burma Cultivators' Leaflet No. 62.	Ditto .	Ditto.
161	Manuring of Paddy in Upper Burma. Burma Department of Agriculture Bulletin No. 27 of 1930. Price, As. 12 or 1s. 1d.	Ditto	Ditto.
162	The Bean crop in Burma, Agricultural Survey No. 8.	Ditto .	Ditto.
163	Survey of conditions of cotton marketing in Berar. Agricultural Survey No. 9.	Ditto .	Ditto.
164	Annual Report of the Department of Agriculture, Bihar and Orissa, for the year 1928-29.	Issued by the Department of Agriculture, Bihar and Orissa.	Government Printing, Bihar and Orissa, Gulzarbagh.
165	Annual Report of the Department of Agriculture, Bihar and Orissa, for 1929-30.	Ditto .	Ditto.
166	Annual Report on Experimental Farms, Bihar and Orissa, for 1928-29.	Ditto .	Ditto.
167	Annual Report on Experimental Farms, Bihar and Orissa, for 1929-30.	Ditto .	Ditto.
168	Annual Report on Experimental Stations in Bihar and Orissa, 1928-29.	Ditto .	Ditto.
169	Annual Report on Experimental Stations in Bihar and Orissa, 1929-30.	Ditto .	Ditto.
170	Bunds in Chota Nagpur Range (English, Bengali and Hindi). Bihar and Orissa Department of Agriculture Bulletin No. 1 of 1930.	Ditto .	Ditto.
171	Sugarcane in Chota Nagpur (English, Bengali, Oriya and Hindi). Bihar and Orissa Department of Agriculture Bulletin No. 2 of 1930.	Ditto .	Ditto.

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE—*contd.*		
172	Summary of Improvements in Agriculture recommended by the Department of Agriculture, Bihar and Orissa Department of Agriculture Bulletin No. 3 of 1930.	Issued by the Department of Agriculture, Bihar and Orissa.	Government Press, Bihas and Orissa, Gulzarbagh.
173	Leaflet on Sugarcane in South-east Bihar Range. Leaflet No. 1 of 1930.	Ditto.	Ditto
174	Sugarcane for Orissa Range. (English and Oriya). Bihar and Orissa Department of Agriculture Leaflet.	Ditto	Ditto.
175	Sugarcane Crushing Mill—its advantages and care. Bihar and Orissa Department of Agriculture Leaflet No. 1 of 1931.	Ditto	Ditto.
176	Water lifts in Bihar and Orissa. Bihar and Orissa Department of Agriculture Leaflet No. 2 of 1931.	Ditto	Ditto.
177	Report on the working of the Department of Agriculture of the Central Provinces, for the year ending 31st March, 1929. Price, Re. 1-7.	Issued by the Department of Agriculture, Central Provincer.	Government Press, Nagpur.
178	Report on the working of the Department of Agriculture of the Central Provinces, for the year ending 31st March, 1930.	Ditto	Ditto.
179	Report on the (1) Agricultural College, Nagpur, (2) Chemical, Botanical, Mycological and Entomological Research, (3) Agricultural Engineer's Section, (4) Maharajbagh Menagerie together with the external work of the Veterinary Inspector attached to the Agricultural College, Nagpur, for the year ending 31st March, 1929. Price, Re. 1.	Ditto	Ditto.

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE—*contd.*		
180	Report on the (1) Agricultural College, Nagpur, (2) Chemical, Botanical Mycological and Entomological Research, (3) Agricultural Engineer's Section, (4) Maharajbagh Menagerie together with the external work of the Veterinary Inspector attached to the Agricultural College, Nagpur, Central Provinces, for the year ending 31st March, 1930. Price, Re. 1.	Issued by the Department of Agriculture, Central Provinces.	Government Press Nagpur.
181	Annual Reports of Experimental Farms of Akola, and the Experimental Farm attached to the Agricultural College, Nagpur, Central Provinces, for the year ending 31st March, 1930. Price, Re. 1.	Ditto	Ditto.
182	Report on Demonstration work carried out in the Western Circle together with reports on the Seed and Demonstration and Cattle Breeding Farms of that circle for the year ending 31st March, 1929. (Vols. I and II). Price, Re. 1 each.	Ditto	Ditto.
183	Report on Demonstration work carried out in the Western Circle, Central Provinces, together with the Reports on the Seed and Demonstration and Cattle Breeding Farms of that Circle for the year ending 31st March, 1930. Vol. I. Price, Re. 1.	Ditto	Ditto.
184	Report on Demonstration work carried out in the Eastern Circle, Central Provinces, together with reports on the Seed and Demonstration Farms at Chandkhuri, Bilaspur and Drug with that of Cattle Breeding Stations attached thereto for the year ending 31st March, 1929. Price, Re. 1.	Ditto	Ditto.

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE—*contd.*		
185	Report on Demonstration work carried out in the Eastern Circle, Central Provinces, together with reports on the Seed and Demonstration Farms at Chandkhuri, Bilaspur and Drug with that of Cattle Breeding Stations attached thereto for the year ending 31st March, 1930. Price, Rs. 2-12.	Issued by the Department of Agriculture, Central Provinces.	Government Press, Nagpur.
186	Report on Demonstration work carried out in Southern Circle together with reports on the Seed and Demonstration Farms, Waraseoni and Sindewahi and the Cattle Breeding Farm, Sindewahi, Central Provinces, for the year ending 31st March, 1929. Price, Re. 1.	Ditto	Ditto.
187	Report on Demonstration work carried out in the Southern Circle, Central Provinces, together with the Reports on the Seed and Demonstration Farms, Waraseoni and Sindewahi and the Cattle Breeding Farm, Sindewahi, for the year ending 31st March, 1930. Price Re. 1.	Ditto	Ditto.
188	Annual Reports of Experimental Farms of the Southern and Eastern Circles, Tharsa and Raipur, Central Provinces, for the year ending 31st March, 1929. Price, Re. 1.	Ditto	Ditto.
189	Annual Reports of Experimental Farms of the Southern and Eastern Circles, Tharsa and Raipur, Central Provinces, for the year ending 31st March, 1930. Price, Re. 1.	Ditto	Ditto.
190	Report on Demonstration work carried out in the Northern Circle, Central Provinces, together with the Reports on the Seed and Demonstration Farms for the year ending 31st March, 1930.	Ditto	Ditto.

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE—*contd.*		
191	Reports on Demonstration work carried out in the Plateau sub-circle, Central Provinces, together with the reports on the Seed and Demonstration Farms of that Circle for the year ending 31st March 1930. Price, Re. 1.	Issued by the Department of Agriculture, Central Provinces.	Government Press, Nagpur.
192	Annual Reports of Experimental Farms of the Northern and Plateau Circles, Powarkhera, Adhartal and Chhindwara, Central Provinces, with that of Cattle Breeding Stations attached thereto for the year ending 31st March, 1930. Price, Re. 1.	Ditto .	Ditto.
193	A Marathi Leaflet on some important points of Groundnut cultivation.	Ditto .	Ditto.
194	A Marathi version of the Royal Commission's Report (Abridged). Adapted from the Hindi version published by the United Provinces Government.	Ditto .	Ditto.
195	The Cultivation of Groundnut (Marathi). Bulletin No. 22 of the Department of Agriculture, Central Provinces. Price, As. 2.	Ditto .	Ditto.
196	A Leaflet of instructions about Rouging alien plants from verum (Marathi).	Ditto .	Ditto.
197	Annual Report on the working of the Department of Agriculture, Assam, for 1928-29. Price As. 14 or 1*s.* 4*d.*	Issued by the Department of Agriculture, Assam.	Government Press, *Assam*, Shillong.
198	Annual Report on the working of the Department of Agriculture, Assam, for 1929-30.	Ditto . .	Ditto.
199	Sweet potato (in Assamese, Bengali and Khasi). Assam Department of Agriculture, Leaflet No. 2 of 1929.	Ditto . .	Ditto.
200	Water-hyacinth. (Assamese.) Assam Department of Agriculture Leaflet No. 1 of 1930.	Ditto . .	Ditto.

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE—*concld.*		
201	Yellowing of Rice seedlings. (Assamese and Bengali). Assam Department of Agriculture Leaflet No. 2 of 1930.	Issued by the Department of Agriculture, Assam.	Government Press, Assam, Shillong.
202	How to improve yield in Paddy. Leaflet No. 2 of 1931 of the Department of Agriculture, Assam. (English, Assamese and Bengali.)	Ditto . .	Ditto.
203	Report of the Mysore Agricultural Department for the year ending 30th June 1930, Parts I and II.	Issued by the Director of Agriculture, Mysore.	Government Press, Bangalore.
203(*a*)	Report of the Mysore Agricultural Department for the year ending 30th June 1931, Parts I and II.	Ditto . .	Ditto.
	AGRICULTURAL STATISTICS.		
204	Agricultural Statistics of India, 1927-28. Vols. I and II. Price, Re. 1-4 per volume.	Issued by the Department of Commercial Intelligence and Statistics, India.	Government of India Central Publication Branch, Calcutta.
205	Agricultural Statistics of India, 1928-29. Vols. I and II. Price, Re. 1-6 and Re. 1-8 resp.	Ditto . .	Ditto.
206	Estimates of Area and Yield of Principal crops in India, 1928-29. Price, As. 14 or 1*s.* 6*d.*	Ditto . .	Ditto.
207	Estimates of Area and Yield of Principal crops in India, 1929-30. Price, As. 14 or 1*s.* 6*d.*	Ditto . .	Ditto.
208	Season and Crop Report of the Madras Presidency for Agricultural year 1928-29. Price, Re. 1-4.	Issued by the Department of Agriculture, Madras.	Government Press, Madras.
209	Season and Crop Report of the Madras Presidency for Agricultural year 1929-30. Price, Re. 1-4.	Ditto . .	Ditto.
210	Season and Crop Report of the Bombay Presidency for the year 1928-29. Price, As. 5.	Issued by the Department of Agriculture, Bombay.	Government Central Press, Bombay.

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
	AGRICULTURAL STATISTICS—*contd.*		
211	Season and Crop Report of the Bombay Presidency for the year 1929-30. Price, As. 5.	Issued by the Department of Agriculture, Bombay.	Government Central Press, Bombay.
212	Season and Crop Report of Bengal for 1928-29.	Issued by the Department of Agriculture, Bengal.	Bengal Secretariat Book Depôt, Calcutta.
213	Season and Crop Report of Bengal for 1929-30.	Ditto . .	Ditto.
214	Monthly and Annual Rainfall Table in the Province of Bengal for 1929.	Ditto . .	Ditto.
215	Monthly and Annual Rainfall Table in the Province of Bengal for 1930.	Ditto . .	Ditto.
216	Season and Crop Report of the United Provinces of Agra and Oudh for the year 1928-29.	Issued by the Department of Land Records, U. P.	Government Press, Allahabad.
217	Season and Crop Report of the United Provinces of Agra and Oudh for the year 1929-30.	Ditto . .	Ditto.
218	Table of Agricultural Statistics of the Punjab for 1928-29.	Issued by the Department of Agriculture, Punjab.	Government Printing, Punjab, Lahore.
219	Season and Crop Report of the Punjab for 1928-29.	Ditto . .	Ditto.
220	Season and Crop Report of the Punjab for 1929-30.	Ditto . .	Ditto.
221	Agricultural Statistics, Bihar and Orissa, 1928-29.	Issued by the Department of Agriculture, Bihar and Orissa.	Goverment Printing, Bihar and Orissa, Gulzarbagh.
222	Agricultural Statistics, Bihar and Orissa, 1929-30.	Ditto . .	Ditto.
223	Season and Crop Report of Bihar and Orissa for 1928-29.	Ditto . .	Ditto.
224	Season and Crop Report of the Central Provinces and Berar for the year 1928-29.	Issued by the Department of Land Records, Central Provinces.	Government Press, Nagpur.
224(*a*)	Report on the Season and Crops of N.-W. F. P. for 1928-29.	Issued by the Revenue Commissioner, N.-W. F. P.	Government Printing and Stationery, N.-W. F. P.

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
	FRUIT CULTURE.		
225	The Production of Oranges in Spain. Pusa Bulletin No. 198. Price, As. 6 or 8*d*.	W. Robertson Brown . .	Government of India Central Publication Branch, Calcutta.
226	Grape Culture in Western India. Bombay Department of Agriculture Bulletin No. 156 of 1928. Price, As. 7.	S. R. Gandhi . .	Ditto.
227	Papaya cultivation in the Bombay Presidency (excluding Sind). Bombay Department of Agriculture Bulletin No. 162 of 1930. Price, As. 3.	G. S. Cheema and P. G. Dani.	Government Central Press, Bombay.
228	Grading of mangoes. Bombay Department of Agriculture Leaflet No. 1 of 1931.	Issued by the Department of Agriculture, Bombay.	Ditto.
229	A List of Fruit Nurseries in the Punjab recommended for the purchase of Plants. Punjab Department of Agriculture Leaflet No. 73.	Issued by the Department of Agriculture, Punjab.	Government Printing, Punjab, Lahore.
230	Tomato Ketchup. Punjab Department of Agriculture Leaflet No. 77.	Ditto . .	Ditto.
231	Candying of fruits. Punjab Department of Agriculture Leaflet No. 78.	Ditto . .	Ditto.
232	How to place oranges in the market. Punjab Department of Agriculture Leaflet No. 79.	Ditto . .	Ditto.
233	On Protection of Fruit Trees from Frost. Punjab Department of Agriculture Leaflet No. 81.	Ditto . .	Ditto.
234	Banana Culture (in Assamese and Bengali). Assam Department of Agriculture Leaflet No. 1 of 1929.	Issued by the Department of Agriculture, Assam.	Government Press, Assam, Shillong.
235	Papaya Culture (in Assamese and Bengali). Assam Department of Agriculture Bulletin No. 1 of 1929.	Ditto . .	Ditto.

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
	SERICULTURE.		
236	The rearing of Eri Silk Worms. Bengal Department of Agriculture Leaflet No. 2 of 1930.	Issued by the Department of Agriculture, Bengal.	Bengal Secretariat Book Depôt, Calcutta.
237	Silk Industry in Bengal. Department of Agriculture Leaflet No. 6 of 1930.	Ditto . .	Ditto.
	AGRICULTURAL SCIENCE.		
237(*a*)	The Indian Journal of Agricultural Science, Vol. I, Parts I, II and III. Annual Subscription Rs. 10, 16*s*. 6*d*.	Issued under the authority of the Imperial Council of Agricultural Research.	Government of India Central Publication Branch, Calcutta.
	AGRICULTURAL CHEMISTRY.		
238	The Application of the Antimony Electrode to the Determination of the pH value and the Lime Requirement of Soils. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. X, No. 4. Price, As. 5 or 6*d*.	W. H. Harrison and P. N. Vridhachalam.	Government of India Central Publication Branch, Calcutta.
239	Some Digestibility Trials on Indian Feeding Stuffs, IV: Some Punjab Hays. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. X, No. 5. Price, As. 7 or 9*d*.	P. E. Lander and Lal Chand Dharmani.	Ditto.
240	Some Digestibility Trials on Indian Feeding Stuffs, V: Feeding trials on American and Indian cotton seeds. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. X, No. 6. Price, As. 7 or 9*d*.	Ditto . .	Ditto.
241	Some Digestibility Trials on Indian Feeding Stuffs, VI: Green Fodders and their Silage. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. X, No. 7, Price, As. 10 or 1*s*.	Ditto . .	Ditto.
242	A New Method of Dispersing Soils for Mechanical Analysis. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. X, No. 8. Price, As. 5 or 6*d*.	Amar Nath Puri . .	Ditto.

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
	AGRICULTURAL CHEMISTRY—*contd.*		
243	A Study of the Capillary Rise of Water under Field conditions. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. X, No. 9. Price, As. 5 or 6 *d.*	Ashutosh Sen . .	Government of India Central Publication Branch, Calcutta.
244	Silage Investigations at Bangalore. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. X, No. 10. Price, As. 10 or 1*s.*	T. S. Krishnan . .	Ditto.
245	Studies in Soil Colloids, Part I — Base exchange and soil acidity; Part II — Factors influencing the dispersion of soil colloids in water. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. XI, Nos. 1 and 2. Price, Re. 1 or 1*s.* 9*d.*	Amar Nath Puri . .	Ditto.
246	Feeding Experiments at Hosur, 1926, 1927 and 1928. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. XI, No. 3. Price, As. 7 or 9*d.*	F. J. Warth . .	Ditto.
247	The Nutritive value of some Typical Indian Hays. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. XI, No. 4. Price, As. 5 or 6*d.*	Ditto . .	Ditto.
248	The Nutritive value of Gram Husk. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. XI, No. 5. Price, As. 6 or 8*d.*	F. J. Warth, and Lal Chand Sikka.	Ditto.
249	Studies in Soil Colloids, Part III—Flocculation of soil colloids. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. XI, No. 6. Price, As. 7 or 9*d.*	Amar Nath Puri . .	Ditto.
250	Studies in Soil Colloids, Part IV—Methods of estimating soil colloids. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. XI, No. 7. Price, As. 5 or 6*d.*	Ditto . . .	Ditto.

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
	AGRICULTURAL CHEMISTRY—*concld.*		
251	Studies in Soil Colloids, Part V—Methods of determining saturation, capacity and degree of saturation of soils. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. XI, No. 8. Price, As. 3 or 4*d*.	Amar Nath Puri . .	Government of India Central Publication Branch, Calcutta.
252	A New Method of Estimating Total Carbonates in Soils. Pusa Bulletin No. 206. Price, As. 3 or 4*d*.	Ditto . . .	Ditto.
253	The Preparation in the Home of Infant and Invalid foods from *Cholam*. (English, Tamil Telugu, Malayalam and Kanarese.) Madras Department of Agriculture Leaflet No. 61.	M. Suryanarayana .	Government Press, Madras.
254	Home-made Malt Foods from Great Millet (*Andropogon Sorghum*). (English, Tamil, Telugu, Malayalam and Kanarese.) Madras Department of Agriculture Leaflet No. 62.	B. Viswanath . .	Ditto.
255	Conversion of Prickly Pear into Manure. (English, Tamil, Telugu, Malayalam and Kanarese.) Madras Department of Agriculture Leaflet No. 63.	Ditto . . .	Ditto.
256	Soils of the Bombay Presidency. Bombay Department of Agriculture Bulletin No. 160 of 1929. Price, As. 7.	D. L. Sahasrabuddhe .	Government Central Press, Bombay.
257	Periodicity of the Nitrate Contents of Soils. (Reprinted from 'Soil Science,' Vol. XXXIX, No. 3, March, 1930.)	H. N. Batham and L. S. Nigam.	Government Press, Allahabad.
	BOTANY.		
258	Studies in Inheritance in cotton. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XVII, No. 4. Price, As. 14 or 1*s*. 6*d*.	Mohammad Afzal . .	Government of India Central Publication Branch, Calcutta.

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
	BOTANY—*contd.*		
259	Cotton Growing in India in relation to climate. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XVII, No. 5. Price, As. 12 or 1*s.* 3*d.*	Trevor Trought and Mohammad Afzal.	Government of India Central Publication Branch, Calcutta.
260	Effect of some Meteorological conditions on the Growth of Punjab American Cotton. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XVII, No. 6. Price, As. 7 or 9*d.*	Trevor Trought . .	Ditto.
261	The Calculation of Linkage Values. A Comparison of various Methods. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XVIII, No. 1. Price, Re. 1 or 1*s.* 6*d.*	Mahbub Alam . .	Ditto.
262	Root Development of Rice under Different Conditions of Growth. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XVIII, No. 2. Price, As. 14 or 1*s.* 6*d.*	R. L. Sethi . . .	Ditto.
263	Studies in Indian Oil Seeds, No. 3, '*Carthamus tinctorius* Linn.' The Types of Safflower. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XVIII, No. 3. Price, As. 4 or 5*d.*	Abdur Rahman Khan .	Ditto.
264	Studies in Gujarat Tobaccos and their Improvement. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XVIII, No. 4. Price, As. 12 or 1*s.* 3*d.*	V. M. Majumdar . .	Ditto.
265	Studies in Indian Oil Seeds, No. 4. The Types of *Sesamum indicum*. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XVIII, No. 5. Price, Re. 1-8-0 or 2*s.* 6*d.*	Kashi Ram . . .	Ditto.

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
	BOTANY—*concld.*		
266	Classification and Study of the characters of the cultivated Rices in the United Provinces. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XVIII, No. 6. Price, Re. 1-10 or 2*s.* 6*d.*	R. L. Sethi and Baijanti Prosad Saxena.	Government of India Central Publication Branch, Calcutta.
267	The Inheritance of Characters in Rice, Part III. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XVIII, No. 7. Price, As. 14 or 1*s.* 6*d.*	K. Ramiah . . .	Ditto.
268	The Inheritance of Characters in Rice, Part IV. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XVIII, No. 8. Price, Re. 1-6 or 2*s.* 3*d.*	K. Ramiah, S. Jobithraj and S. Dharmalinga Mudaliar.	Ditto.
269	Studies in *Cajanus indicus*. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XIX, No. 1. Price, Re. 1-14 or 3*s.* 3*d.*	D. N. Mahta and B. B. Dave.	Ditto.
270	Studies in Indian Pulses, (2) Some varieties of Indian Gram (*Cicer arietinum* Linn.). Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XIX, No. 2. Price, Re. 1-12 or 3*s.*	F. J. F. Shaw and Abdur Rahman Khan.	Ditto.
271	List of Publications on the Botany of Indian Crops. Pusa Bulletin No. 202. Price, Rs. 3-8 or 6*s.*	Compiled by F. J. F. Shaw and Rakhal Das Bose.	Ditto.
272	The Grain Shedding Character in Rice Plants and its Importance. Pusa Bulletin No. 205. Price, As. 12 or 1*s.* 3*d.*	S. G. Bhalerao . .	Ditto.
	MYCOLOGY.		
273	Cotton Wilt. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XVII, No. 3. Price, Re. 1-4 or 2*s.* 3*d.*	Jehangir Fardunji Dastur	Government of India Central Publication Branch, Calcutta.

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
	MYCOLOGY—*contd.*		
274	A Leaf-spot disease of *Andropogon Sorghum* caused by *Cercospora Sorghi* E. & E. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XVIII, No. 9. Price, As. 10 or 1*s.*	T. S. Ramakrishnan .	Government of India Central Publication Branch, Calcutta.
275	*Sorosporium Paspali* McAlp. on *Paspalum scrobiculatum* L., Kodra Smut. Pusa Bulletin No. 201. Price, As. 8 or 10*d.*	Abdus Sattar . .	Ditto.
276	Red-rot disease of sugarcane. Madras Department of Agriculture Leaflet No. 30. (English, Tamil, Telugu, Kanarese and Malayalam.)	S. Sundararaman . .	Government Press, Madras.
277	The Mosaic disease of sugarcane. Madras Department of Agriculture Leaflet No. 31. (English, Tamil, Telugu, Kanarese and Malayalam.)	Ditto . . .	Ditto.
278	Cocoanut Stem bleeding disease. Madras Department of Agriculture Leaflet No. 32.	Ditto . . .	Ditto.
279	Sprayers and Spraying. Madras Department of Agriculture Leaflet No. 34. (English, Tamil, Telugu, Malayalam and Kanarese.)	Ditto . . .	Ditto.
280	Bud-rot palmyras. Madras Department of Agriculture Leaflet No. 36. (English, Tamil, Telugu, Malayalam and Kanarese.)	Ditto . . .	Ditto.
281	Powdery mildew of the grape and its control in Bombay. Bombay Department of Agriculture Bulletin No. 163 of 1930. Price, As. 3.	B. N. Uppal, G. S. Cheema and M. Kamat.	Government Central Press, Bombay.
282	Betelvine disease. Bengal Department of Agriculture Leaflet No. 5 of 1930. (English and Bengali.)	Issued by the Department of Agriculture, Bengal.	Bengal Secretariat Book Depôt, Calcutta.
283	Root-rot of Paddy. Bengal Department of Agriculture, Leaflet No. 8 of 1930. (English and Bengali.)	Ditto . .	Ditto.

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
	MYCOLOGY—*concld.*		
284	Ufra disease in Paddy (Bengali). Leaflet No. 2 of 1931 of the Department of Agriculture Bengal.	Issued by the Department of Agriculture, Bengal.	Bengal Secretariat Book Depot, Calcutta.
285	Spraying of Betelvines (English and Bengali). Leaflet No. 5 of 1931 of the Department of Agriculture, Bengal.	Ditto . .	Ditto.
286	The Early Blight of Potatoes and its Control. Punjab Department of Agriculture, Leaflet No. 83.	Issued by the Department of Agriculture, Punjab.	Government Printing, Punjab, Lahore.
287	Grain Smut of *Jowar* and its Prevention. Punjab Department of Agriculture Leaflet No. 85.	Ditto . .	Ditto.
288	Seasonal Periodicity of Coffee Leaf Disease (*Hemelia Vastarix*, B. and Br.) Mysore Coffee Experiment Station, Bulletin No. 4.	Issued by the Department of Agriculture in Mysore.	Government Press, Bangalore.
	ENTOMOLOGY.		
289	A condition towards our knowledge of the Aleyrodidae (White Flies) of India. A new Coccid injurious to Fruit Trees in Baluchistan. Memoirs of the Department of Agriculture in India, Entomological Series, Vol. XII, Nos. 1 and 2. Price, Rs. 3-2 or 5*s*. 6*d*.	Karam Singh and F. Laing.	Government of India Central Publication Branch, Calcutta.
290	Carabidae. Catalogue of Indian Insects, Part 18. Price, Rs. 8-10 or 14*s*. 6*d*.	H. E. Andrews . .	Ditto.
291	Gyrinoidea. Catalogue of Indian Insects, Part 19. Price, As. 12 or 1*s*. 3*d*.	George Ochs . . .	Ditto.
292	A contribution to our knowledge of south Indian Coccidae. Pusa Bulletin No. 197. Price, Rs. 2-12 or 5*s*.	T. V. Ramakrishna Ayyar	Ditto.
293	List of Publications on Indian Entomology, 1928. Pusa Bulletin No. 200. Price, As. 7 or 9*d*.	Compiled by the Imperial Entomologist, Pusa.	Ditto.

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
	ENTOMOLOGY—*contd.*		
294	List of Publications on Indian Entomology, 1929. Pusa Bulletin No. 207. Price, As. 10 or 1*s.*	Complied by the Imperial Entomologist Pusa.	Government of India Central Publication Branch, Calcutta.
295	Red Hairy Caterpillar Pest. (English, Tamil, Telugu and Malayalam.) Madras Department of Agriculture Leaflet No. 2 (Revised).	Y. Ramachandra Rao. .	Government Press, Madras.
296	Army Worm of Paddy. Madras Department of Agriculture Leaflet No. 14. (English, Tamil Telugu, Kanarese and Malayalam.) Free.	Ditto . .	Ditto.
297	Prickly pear cochineal. Madras Department of Agriculture Leaflet No. 35. (English, Tamil, Telugu, Malayalam and Kanarese.) Free.	T. V. Ramakrashna Ayyar	Ditto.
298	How to Control the Jasmine Bug (English, Tamil, Telugu and Kanarese). Madras Department of Agriculture Leaflet No. 66. Free.	Y. Ramachandra Rao .	Ditto.
299	Hairy Caterpillar Pest on Dry Crops. (English, Tamil and Telegu.) Madras Department of Agriculture pamphlet.	Issued by the Department of Agriculture, Madras.	Ditto.
300	Mango-hoppers and mildew and their control. Bombay Department of Agriculture Leaflet No. 6 of 1930. (With vernacular versions.)	Issued by the Department of Agriculture, Bombay.	Government Printing and Stationery, Bombay.
301	Destruction of rice grass-hoppers. Bombay Department of Agriculture Leaflet No. 7 of 1930.	Ditto . .	Ditto.
302	Control of the red pumpkin beetle. Bombay Department of Agriculture Leaflet No. 9 of 1930.	Ditto . .	Ditto.
303	Insects and general control of Insect Pests. Bengal Department of Agriculture Bulletin No. 3 of 1929.	Issued by the Department of Agriculture, Bengal.	Sreenath Press, Dacca.
304	Rice Hispa (Bengalee). Bengal Department of Agriculture Leaflet No. 1 of 1930.	Ditto . .	Bengal Secretariat Book Depot, Calcutta.

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
	ENTOMOLOGY—*concld.*		
305	On Maize and *Jowar* Borers and their control. Punjab Department of Agriculture Leaflet No. 82.	Issued by the Department of Agriculture, Punjab.	Government Printing, Punjab, Lahore.
306	San Jose Scale (*Comstockaspis perniciosa*, Comst.) and its control. Punjab Department of Agriculture Leaflet No. 88.	Ditto . .	Ditto.
307	The Sugarcane Leaf-hopper (*Pyrilla* spp.) and its control. Punjab Department of Agriculture Leaflet No. 89.	Ditto . .	Ditto.
308	Pamphlet on "Methods for the control of locusts" published by the Imperial Council of Agricultural Research (in Gurmukhi).	Ditto . .	Ditto.
309	A Leaflet on Common Insecticides and their uses.	Issued by the Department of Agriculture, Central Provinces.	C. P. Government Printing, Nagpur.
310	Common Insecticides and their control. Leaflet of the Department of Agriculture, Central Provinces. (Hindi and Marathi.)	Ditto . .	Ditto.
311	Instructions for control of Locusts. Leaflet of the Department of Agriculture, Central Provinces. (Hindi and Marathi.)	Ditto . .	Ditto.
312	The Coffee Berry Borer (*Stephanoderes hampei*), a preliminary account (English and Kannada). Mysore Coffee Experiment Station Bulletin No. 2.	Issued by the Director of Agriculture in Mysore.	Government Press, Bangalore.
	BACTERIOLOGY.		
313	The Influence of Exchangeable Ions in Soil Colloids on Bacterial Activity and Plant Growth. Memoirs of the Department of Agriculture in India, Bacteriological Series, Vol. II, No. 4. Price, As. 7 or 9*d*.	N. V. Joshi and A. N. Puri.	Government of India Central Publication Branch, Calcutta.

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
	BACTERIOLOGY—*contd.*		
314	A Method of Increasing the Manurial Value of Bone Phosphate. Pusa Bulletin No. 204. Price, As. 8 or 10*d.*	N. D. Vyas . . .	Government of India Central Publication Branch, Calcutta.
	ANIMAL HUSBANDRY AND DAIRYING.		
315	The *Journal of the Central Bureau for Animal Husbandry and Dairying in India*, Vol. III, Parts III and IV. Vol. IV, Parts I, II, III and IV. Price, As. 10 per part. Annual subscription, Rs. 2-8.	Issued under the authority of the Imperial Council of Agricultural Research.	Government of India Central Publication Branch, Calcutta.
316	Breeding and Rearing of Cattle and Buffaloes (Revised). (Tamil, Telugu, Malayalam and Kanarese.) Madras Department of Agriculture Leaflet No. 31.	R. W. Littlewood . .	Government Press, Madras.
317	Notes on Ensilage (Revised). (Tamil, Telugu, Malayalam and Kanarese.) Madras Department of Agriculture Leaflet No. 43.	Ditto . .	Ditto.
318	Conditions to be fulfilled for the Grant of Government Premia for Breeding Bulls maintained by Private Bodies (Revised).	Ditto . .	Ditto.
319	Rations of Milch cows, Dry cows and calves. Reprint (English, Tamil, Telugu, Kanarese and Malayalam). Madras Department of Agriculture, Leaflet No. 60. Free.	Ditto . .	Ditto.
320	Broad Hints for everyday use, No. II. Feed your cow. (English, Tamil, Telugu, Malayalam and Kanarese.) Madras Department of Agriculture Leaflet No. 70. Free.	Ditto . .	Ditto.
321	Note on the Cultivation and Management of Grassland at the Hosur Live-stock Station, Madras. Madras Department of Agriculture, Pamphlet No. 1.	Ditto . .	Ditto.

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
	ANIMAL HUSBANDRY AND DAIRYING—*contd.*		
322	*Ragi* Silage in Coimbatore District. Madras Department of Agriculture Notes No. 5. (English and Tamil.)	K. Gopala Krishna Raju	Government Press, Madras.
323	Cattle Feeds of Western India. Bombay Department of Agriculture Bulletin No. 161 of 1930. Price, A. 1.	D. L. Sahasrabuddhe .	Government Central Press, Bombay.
324	Ensilage or Silage in Bengal. Bengal Department of Agriculture Leaflet No. 3 of 1930.	Issued by the Department of Agriculture, Bengal.	Bengal Secretariat Book Depot, Calcutta.
325	Fodder Grass (English and Bengalee). Bengal Department of Agriculture Leaflet No. 4 of 1930.	Ditto . .	Ditto.
326	List of Horse and Cattle Fairs and Shows in the Punjab and Punjab States during 1929-30.	Issued by the Director of Veterinary Services, Punjab, Lahore.	Government Printing, Lahore.
327	Sheep Breeding. Punjab Veterinary Department Leaflet No. 4.	Ditto . .	Ditto.
328	The Table of Poultry Industry. Punjab Department of Agriculture Leaflet No. 87.	Issued by the Department of Agriculture, Punjab.	Ditto.
329	Ranikhet Disease of Fowls. Punjab Department of Agriculture Leaflet No. 93.	Ditto . .	Ditto.
330	Suggested Rations for Municipal Bullocks, etc., in Bihar and Orissa. Bihar and Orissa Department of Agriculture Leaflet No. 2 of 1930.	Issued by the Department of Agriculture, Bihar and Orissa.	Government Printing Bihar and Orissa, Gulzarbagh.
331	Report on the Cattle Breeding Operations in the Central Provinces and Berar for the year ending 31st March 1929. Price Re. 1.	Issued by the Department of Agriculture, Central Provinces.	Central Provinces Government Printing, Nagpur.
332	Report on the Cattle Breeding Operations in the Central Provinces and Berar for the year ending 31st March 1930. Price, Re. 1.	Ditto . .	Ditto.

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
	ANIMAL HUSBANDRY AND DAIRYING—*concld.*		
333	Summary of the Conclusions and Recommendations of the Royal Commission on Agriculture in India with regard to Cattle (Assamese and Bengali). Assam Department of Agriculture, Leaflet No. 3 of 1929.	Issued by the Department of Agriculture, Assam.	Government Press, Assam, Shillong.
334	Suggestions for improving the Health of Cattle in Assam. Leaflet No. 1 of 1931 of the Department of Agriculture, Assam.	Ditto . .	Ditto.
	VETERINARY.		
335	*The Indian Journal of Veterinary Science and Animal Husbandry*, Vol. I, Parts I and II. Annual subscription, Rs. 5 or 8*s*. 3*d*.	Issued under the authority of the Imperial Council of Agricultural Research.	Government of India Central Publication Branch, Calcutta.
336	*The Indian Veterinary Journal* (The Journal of the All-India Veterinary Association). Quarterly. Annual subscription, Rs. 4 or 6*s*. 4*d*. for members and students, Rs. 8 or 10*s*. for others.	P. Srinivasa Rao . .	Peoples' Printing and Publishing House Ltd., Triplicane, Madras.
337	Annual Report of the Imperial Institute of Veterinary Research, Muktesar, for the year ending 31st March 1929. Price, Re. 1-4 or 2*s*.	Issued by the Director, I. I. V. R., Muktesar.	Government of India Central Publication Branch, Calcutta.
338	Annual Report of the Imperial Institute of Veterinary Research, Muktesar, for the year ending 31st March 1930. Price, Re. 1-6 or 2*s*. 3*d*.	Ditto . .	Ditto.
339	The Problems of Rinderpest in India, Pusa Bulletin No. 199. Price, Re. 1-4 or 2*s*. 3*d*.	J. T. Edwards . .	Ditto.
340	The Description of a New Fluke found in the House Crow (*Corvus splendens*). Pusa Bulletin No. 203.	V. R. Phadke and Amar Nath Gulati.	Ditto.
341	Annual Administration Report of the Madras Civil Veterinary Department for the year 1928-29.	Issued by the Director of Veterinary Services, Madras.	Government Press, Madras.

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
	VETERINARY—*contd.*		
342	Annual Administration Report of the Madras Civil Veterinary Department for the year 1929-30. Price, Re. 1.	Issued by the Director of Veterinary Services, Madras.	Government Press, Madras.
343	Scientific Papers of the Civil Veterinary Department, Madras, Vol. I.	Ditto . .	Ditto.
344	Annual Administration Report of the Bombay Veterinary College, Bombay City and Harbour Veterinary Department and Civil Veterinary Department in the Bombay Presidency (including Sind) for the year 1928-29. Price, As. 3 or 4*d.*	Issued by the Principal, Bombay Veterinary College, Superintendent, Civil Veterinary Department, Bombay Presidency, Poona, Superintendent, C. V. D., Sind and Rajputana.	Government Central Press, Bombay.
345	Annual Administration Report of the Bombay Veterinary College, Bombay City and Harbour Veterinary Department and Civil Veterinary Department in the Bombay Presidency (including Sind) for the year 1929-30. Price, As. 4 or 5*d.*	Ditto . .	Ditto.
346	Annual Reports of Civil Veterinary Department and Bengal Veterinary College for 1928-29. Price, Re. 1-4 or 2*s.*	Director and Veterinary Adviser to Government of Bengal.	Bengal Secretariat Book Depot, Calcutta.
347	Annual Reports of Civil Veterinary Department and Bengal Veterinary College for 1929-30. Price, Re. 1-4 or 2*s.*	Ditto . . .	Ditto.
348	Care and management of cattle in Bengal. (Translation in Bengali of the English pamphlet.)	Issued by the Department of Agriculture, Bengal.	Bengal Government Press, Calcutta.
349	Annual Report of the Civil Veterinary Department, United Provinces, for the year 1928-29. Price, Re. 1-12.	Director, Civil Veterinary Department, United Provinces.	Printing and Stationery, United Provinces.
350	Annual Report of the Civil Veterinary Department, United Provinces, for the year 1929-30. Price, Rs. 2.	Ditto . .	Ditto.

List of Agricultural Publications in India during 1929-31—contd.

No.	Title	Author	Where published
	VETERINARY—*contd.*		
351	Annual Report of the Civil Veterinary Department, Punjab, for the year 1928-29.	Issued by the Director, Veterinary Services, Punjab.	Government Printing, Punjab.
352	Annual Report of the Civil Veterinary Department, Punjab, for the year 1929-30. Price, Rs. 3 or 4*s.* 6*d.*	Ditto . .	Ditto.
353	List of Horses and Cattle Fairs and Shows in the Punjab and Punjab States during the year 1930-31.	Ditto . .	Ditto.
354	On Rinderpest. Punjab Veterinary Department Leaflet No. 1.	Ditto . .	Ditto.
355	On Haemorrhagic Septicaemia. Punjab Veterinary Department Leaflet No. 2.	Ditto . .	Ditto.
356	On Foot-and-Mouth Disease. Punjab Veterinary Department Leaflet No. 3.	Ditto . .	Ditto.
357	Report on the Civil Veterinary Department, Burma (including the Insein Veterinary School), for the year ended the 31st March 1929. Price, Re. 1-4 or 1*s.* 11*d.*	Issued by the Director, Veterinary Services, Burma.	Government Press, Rangoon.
358	Report on the Civil Veterinary Department, Burma (including the Insein Veterinary School), for the year ended 31st March 1930. Price, Rs. 2 or 3*s.*	Ditto . .	Ditto.
359	Interim Report on the Immunization of Draft Animals in Burma against Anthrax.	Ditto . .	Ditto.
360	Parasitic Worms of Domestic Animals. Burma Veterinary Department Bulletin No. 7 of 1928 (Burmese).	Ditto . .	Ditto.
361	Instruction for the inoculation of animals with serum virus or Vaccine and notes on the care, handling and sterilization of hypodermic syringes. Burma Veterinary Department Pamphlet No. 1 of 1930.	Ditto . .	Ditto.

List of Agricultural Publications in India during 1929-31—concld.

No.	Title	Author	Where published
	VETERINARY—*concld.*		
362	Instructions for the use of Anthrax Vaccine. Burma Veterinary Department Leaflet No. 1 of 1930.	Issued by the Director, Veterinary Services, Burma.	Government Press, Rangoon.
363	Annual Report of the Civil Veterinary Department, Bihar and Orissa, for the year 1928-29. Price, Re. 1.	Director, Civil Veterinary Department, Bihar and Orissa.	Government Press, Bihar and Orissa, Gulzarbagh.
364	Annual Report of the Civil Veterinary Department, Bihar and Orissa, for the year 1929-30. Price, Re. 1.	Ditto . .	Ditto.
365	Report of the Civil Veterinary Department, Assam, for the year 1928-29. Price, As. 5 or 5*d*.	Superintendent, Civil Veterinary Department, Assam.	Government Press, Shillong.
366	Report of the Civil Veterinary Department, Assam, for the year 1929-30. Price, As. 5 or 6*d*.	Ditto . .	Ditto.
367	Report of the Civil Veterinary Department, North-West Frontier Province, for the year 1928-29. Price, Re. 1-13 or 3*s*. 3*d*.	Superintendent, Civil Veterinary Department, North-West Frontier Province.	Manager, Government Printing and Stationery, North-West Frontier Province, Peshawar.
368	Report of the Civil Veterinary Department, North-West Frontier Province, for the year 1929-30. Price, Re. 1-11 or 3*s*.	Ditto . .	Ditto.

APPENDIX XIV.

Key to the Diagrammatic Map of Agricultural Stations.

Research Institutes and Agricultural Colleges

IMPERIAL.
Pusa (Bihar and Orissa).

MADRAS.
1. Coimbatore.

BOMBAY.
Presidency proper.
1. Poona.

Sind.
2. Sakrand.

BENGAL.
1. Dacca.

UNITED PROVINCES.
1. Cawnpore.

PUNJAB.
1. Lyallpur.

BURMA.
1. Mandalay.

BIHAR AND ORISSA.
1. Sabour.

CENTRAL PROVINCES.
1. Nagpur.

ASSAM.
1. Jorhat.

Special or Subsidiary Research Stations and Research Farms

IMPERIAL.
Bangalore (Mysore).
Coimbatore (Madras).
Anand (Bombay).

MADRAS.
1. Anakapalle.
2. Maruteru.
3. Nandyal.
4. Hagari.
5. Palur.
6. Adutural.
7. Koilpatti.
8. Burliar.
9. Coonoor.
10. Kallar.
11. Pattambi.
12. Kasargod.
13. Guntur.

BOMBAY.

Presidency proper.
1. Surat.
2. Nadiad.
3. Dhulia.
4. Manjri.
5. Dharwar.
6. Karjat.

Sind.
7. Larkana.

BENGAL.
1. Berhampore.
2. Rangpur.
3. Kurseong.
4. Kalimpong.

UNITED PROVINCES.
1. Shahjahanpore.
2. Muttra.
3. Cawnpore.
4. Farrukhabad.

Main Experimental Farms

BOMBAY.

Presidency proper.
1. Ratnagiri.
2. Dhulia.
3. Jalgaon.
4. Surat.

Sind.
5. Mirpurkhas.

BENGAL.
1. Chinsura.
2. Rajshahi.

UNITED PROVINCES.
1. Cawnpore.
2. Gorakhpore.
3. Partabgarh.
4. Aligarh.
5. Muzaffarnagar.
6. Jeolikote.

PUNJAB.
1. Hansi.
2. Montgomery.
3. Multan.
4. Gurdaspur.
5. Sargodha.
6. Rawalpindi.
7. Sirsa.
8. Kala Shah Kaku.
9. Harappa Road.

BURMA.
1. Maungmya.
2. Hmawbi.
3. Mudon.
4. Akyab.
5. Allanmyo.
6. Pyinmana.
7. Mahlaing.
8. Kanbalu.

Small Farms, District Farms and Demonstration Farms

MADRAS.
1. Samalkota.
2. Palakuppam.
3. Vellalore.
4. Taliparamba.
5. Pilicode.
6. Nileshwar.

BOMBAY.

Presidency proper.
1. Kumta.
2. Mugad.
3. Gokak Canal.
4. Hatkhamba.
5. Mohol.
6. Baramati.
7. Kopargaon.
8. Amalsad.
9. Broach.
10. Bohad.
11. Viramgam.

Sind.
12. Sukkur.
13. Jacobabad.
14. Dadu.
15. Oderolal.
16. Lundo.

BENGAL.
1. Burdwan.
2. Berhampore.
3. Bankura.
4. Suri.
5. Krishnagar.
6. Jessore.
7. Gosaba.
8. Faridpur.
9. Rangamati.
10. Comilla.
11. Barisal.
12. Kishoreganj.
13. Mymensingh.

Seed Farms

MADRAS.
1. Nanjanad.

UNITED PROVINCES.
1. Naugawan.
2. Kalianpur.
3. Kalai.

PUNJAB.
1. Fatna.
2. Shergarh.
3. Vihari.
4. Risalewala.
5. Chillianwala.
6. Sargodha.

BURMA.
1. Shwebo (Chiba).
2. Kyehmon.
3. Singaing.
4. Pwinbyu.
5. Magwe.
6. Pyu.
7. Paungde.
8. Henzada.
9. Pegu.
10. Maubin.
11. Thaton.

CENTRAL PROVINCES.
1. Saugor.
2. Damoh.
3. Bilaspur.
4. Chandkhuri.
5. Drug.
6. Seoni.
7. Betul.
8. Khandwa.
9. Wara-Seoni.
10. Basim.
11. Yeotmal.
12. Sindewahi.
13. Narsinghpur.
14. Buldana.
15. Borgaon.

Major Cattle-breeding Farms

IMPERIAL.
Wellington (Madras).
Karnal (Punjab).

MADRAS.
Hosur.

BOMBAY.

Presidency proper.
1. Chharodi.
2. Bankapur.

Sind.
3. Malir.

BENGAL.
1. Rangpur.

UNITED PROVINCES.
1. Muttra.
2. Kheri.

PUNJAB.
1. Hissar.

BURMA.
1. Tatkon.

BIHAR AND ORISSA.
1. Kanke.
2. Monghyr.
3. Sepaya.

CENTRAL PROVINCES.
1. Telinkheri.
2. Raigarh (Garhi).
3. Pendra.
4. Ellichpur.
5. Bod.

ASSAM.
1. Khanpara.

Subsidiary Cattle-breeding Farms

MADRAS.
1. Guntur.
2. Chintaladevi.

BOMBAY.

Presidency proper.
1. Tegur.
2. Sangvi.
3. Surat.

CENTRAL PROVINCES.
1. Powarkhera.
2. Richal.
3. Nagpur College Dairy Farm.

PUNJAB.
1. Risalewala.

CENTRAL PROVINCES.
1. Akola.

BIHAR AND ORISSA.
1. Kanke.
2. Gaya.
3. Sepaya.
4. Cuttack.

CENTRAL PROVINCES.
1. Raipur.
2. Powarkhera.
3. Adhartal.
4. Nagpur.

ASSAM.
1. Karimganj.
2. Upper Shillong.
3. Titabor.

N.-W. F. PROVINCE.
1. Tarnab

14. Pabna.
15. Dhanbari.
16. Bogra.
17. Jamalpur.
18. Rangpur.
19. Malda.
20. Dinajpur.
21. Mainaguri.

UNITED PROVINCES.
1. Benares.
2. Fyzabad.
3. Etawah.
4. Mainpuri.
5. Bichpuri.
6. Jachonda.
7. Hardoi.
8. Bahraich.
9. Bulandshahr.
10. Jaitpur.
11. Budaun.
12. Nagina.
13. Nawabganj.
14. Meerut.
15. Atarra.

PUNJAB.
1. Gurgaon.
2. Rohtak.
3. Karnal.
4. Ambala.
5. Ludhiana.
6. Jullundur.
7. Beas.
8. Kangra.
9. Ferozepur.
10. Gujranwala.
11. Gujrat.
12. Jhang.
13. Dera Ghazi Khan.
14. Mianwali.
15. Campbellpur.

BURMA.
1. Padu.
2. Paukkaung.
3. Sa-alng.
4. Kyaukpyu.

BIHAR AND ORISSA.
1. Balasore.
2. Anandpur.
3. Puri.
4. Khurda.
5. Angul.

Key to the Diagrammatic Map of Agricultural Stations—contd.

Research Institutes and Agricultural Colleges	Special or Subsidiary Research Stations and Research Farms	Main Experimental Farms	Small Farms, District Farms and Demonstration Farms	Seed Farms	Major Cattle-breeding Farms	Subsidiary Cattle-breeding Farms
			BIHAR AND ORISSA—*contd.* 6. Purulia. 7. Ramgarh. 8. Neterhat. 9. Nawadah. 10. Jamui. 11. Banka. 12. Darbhanga. 13. Siwan. 14. Bikramgunj. 15. Siris. 16. Chianki. 17. Chaibassa. 18. Sambalpur. CENTRAL PROVINCES. 1. Chhindwara. 2. Tharsa. N.-W. F. PROVINCE. 1. Haripur. 2. Parachinar.			
HYDERABAD. 1. Himayat Sagar. 2. Parbhani. MYSORE STATE. 1. Bangalore. TRAVANCORE STATE. 1. Quilon. BHOPAL STATE. 1. Nabi Bagh. PATIALA STATE. 1. Patiala. NON-OFFICIAL. Indore (Central India—Institute of Plant Industry). Ranchi (Bihar and Orissa—Lac Research Institute). Tocklai (Assam—Indian Tea Association).	HYDERABAD STATE. 1. Nizamsagar. TRAVANCORE STATE. 1. Porakad. NON-OFFICIAL. Mooply (Cochin—U. P. A. S. I.). Peermade (Travancore—U. P. A. S. I.). Aneikulam (Travancore—U. P. A. S. I.). Tenmalai (Travancore—U. P. A. S. I.).	HYDERABAD STATE. 1. Sangareddy. 2. Alir. 3. Mahbubnagar. MYSORE STATE. 1. Hebbal. 2. Naggenhalli. 3. Hansur. 4. Marthur. 5. Balehonnur. 6. Babbur. 7. Yellachihalli. BARODA STATE. 1. Baroda. 2. Jagudan. 3. Amreli. TRAVANCORE STATE. 1. Alleppey. 2. Koni. 3. Nagercoil. NON-OFFICIAL. Sidapur (Madras—U. P. A. S. I.).	MYSORE STATE. 1. Chickanhalli. 2. Hassan. 3. Ramkrishnapur. 4. Mysore Irwin Canal. TRAVANCORE STATE. 1. Alwaye. 2. Oachira. 3. Vaikom. 4. Kottarakara. 5. Eraniel. 6. Pulliyara. 7. Cape Comorin. NON-OFFICIAL. Borbhetta (Assam—Indian Tea Association).	HYDERABAD STATE. 1. Hyderabad. MYSORE STATE. 1. Parvatharayanakere. TRAVANCORE STATE. 1. Trivandrum. 2. Esanthimangalam.	

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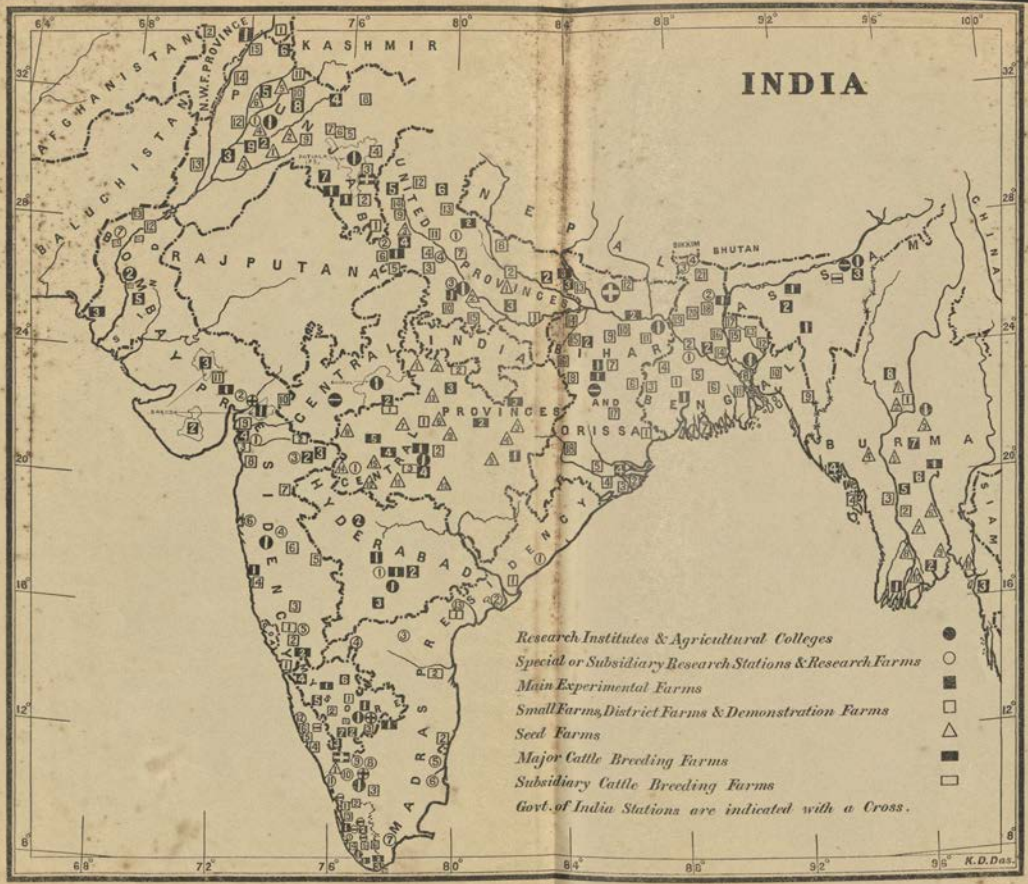
INDIA
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BALUCHISTAN
N.W.F. PROVINCE
KASHMIR
PUNJAB
UNITED PROVINCES
RAJPUTANA
BOMBAY PRESIDENCY
CENTRAL INDIA
CENTRAL PROVINCES
HYDERABAD
MYSORE
COORG
MADRAS PRESIDENCY
NEPAL
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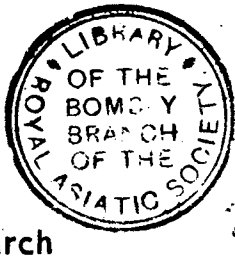
BENGAL
BURMA
CHINA
SIAM
Research Institutes & Agricultural Colleges
Special or Subsidiary Research Stations & Research Farms
Main Experimental Farms
Small Farms, District Farms & Demonstration Farms
Seed Farms
Major Cattle Breeding Farms
Subsidiary Cattle Breeding Farms
Govt. of India Stations are indicated with a Cross.
K.D.Das.

Review of Agricultural Operations in India

1931-32 & 1932-33



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PALESTINE.

Steimatzky, Jerusalem

INDIA.

(*a*) PROVINCIAL GOVERNMENT BOOK DEPOTS.

MADRAS :—Superintendent, Government Press, Mount Road, Madras.

BOMBAY :—Superintendent, Government Printing and Stationery, Queen's Road, Bombay.

SIND :—Library attached to the Office of the Commissioner in Sind, Karachi.

UNITED PROVINCES OF AGRA AND OUDH :—Superintendent of Government Press, United Provinces of Agra and Oudh Allahabad.

PUNJAB :—Superintendent, Government Printing, Punjab, Lahore.

BURMA :—Superintendent, Government Printing, Burma, Rangoon.

CENTRAL PROVINCES AND BERAR :—Superintendent, Government Printing, Central Provinces, Nagpur.

ASSAM :—Superintendent, Assam Secretariat Press, Shillong.

BIHAR AND ORISSA :—Superintendent, Government Printing, Bihar and Orissa, P. O. Gulzarbagh, Patna.

NORTH-WEST FRONTIER PROVINCE :—Manager, Government Printing and Stationery, Peshawar.

(*b*) PRIVATE BOOK-SELLERS.

Aero Stores, Karachi City.*
Albert Library, Dacca.
Banerjee & Bros., Ranchi, Messrs. G.
Bantherya & Co., Ltd., Kucheri Road, Ajmer.
Bengal Flying Club, Dum Dum Cantt.*
Bhawnani & Sons, New Delhi.
Book Company, Calcutta.
Booklover's Resort, Talkad, Trivandrum, South India.
Burma Book Club, Ltd., Rangoon.
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Chatterjee & Co., 3, Bacharam Chatterjee Lane, Calcutta.
Chukerverty, Chatterjee & Co., Ltd., 13, College Square, Calcutta.
City Book Co., Madras.
City Book House, Meston Road, Cawnpore.
Commercial Book Co., Lahore.
Das Gupta & Co., 54/3, College Street, Calcutta.
Deccan Bookstall, Poona 4.
Delhi and U. P. Flying Club, Ltd., Delhi.*
English Book Depot, Ferozepore.
English Book Depot, Taj Road, Agra, and Saddar Bazar, Jhansi.
English Book Depot, Bank Road, Ambala Cantt. and Kasauli.
English Bookstall, Karachi.
Fakir Chand Marwah, Peshawar Cantonment.
Fono Book Agency, Simla.
Gaya Prasad & Sons, Agra.
Grantha Mandir, Cuttack.
Higginbothams, Madras.
Hindu Library, 137-F, Balaram De Street, Calcutta.
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PREFACE.

This review is based on a number of Provincial and State reports relating to agricultural years terminating on various dates, but so far as possible the review of the position of agricultural research has been brought up to the end of 1933. A number of officers have contributed to the review and the assistance of the following officers, amongst others, is gratefully acknowledged :—

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2. Various circumstances, of which shortage in staff consequent on a period of financial stringency was by no means the least important, have delayed the issue of this publication. A review for 1933-34 and 1934-35 is now under preparation.

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Review of Agricultural Operations in India, 1931-32 and 1932-33

CHAPTER I.

AGRICULTURAL CONDITIONS DURING 1931-32 AND 1932-33.

1. Agricultural and Climatic Conditions.

1931-32

Except for an almost rainless area in and around Sind, the monsoon of 1931 on the whole was well-distributed, but at a few places heavy rains resulted in floods, causing damage to the crops. Averaged over the plains of India, the total rainfall during the monsoon period was only four per cent. above the normal. During the important retreating period of the monsoon, rainfall was normal or nearly so in Burma, Assam, the North-West Frontier Province, Mysore and the Punjab, but above the average elsewhere. Taking the year as a whole, the total rainfall was within 25 per cent. of the normal; in Berar, Bombay and West Rajputana it was above normal and markedly so in the Konkan and Malabar. The season may thus, on the whole, be regarded as fairly good from the agricultural standpoint. A good yield was obtained for the rice crop of 1931-32, except in Burma, and the total production exceeded the previous year's plentiful harvest by two per cent. Sugarcane also gave a record yield which was 21 per cent. above that of 1930-31. The wheat crop of 1930-31, most of which was moved during the year under review, was also satisfactory, having exceeded the average of the preceding five years by eight per cent. Following on two very large crops in succession in 1929 and 1930, the area under jute was considerably reduced in 1931 and the outturn amounted to only 56 lakhs of bales, which is not much

more than half of the average outturn during the preceding five seasons. The cotton crop of 1931-32 was the lowest since 1921-22, the production being 22 per cent. less than in 1930-31. Among the oil-seed crops, castor seed gave an increased production in 1931-32, while sesamum and groundnut gave smaller outturns, being 12 and 14 per cent. respectively, less than that of 1930-31. The production of linseed was practically the same as in the preceding season, while that of rape and mustard showed a decrease.

In MADRAS the South-West monsoon was on the whole below the average except in the West Coast and some nine districts in the north-eastern areas. The North-East monsoon was above the average except in the Deccan and Malabar.

In BOMBAY the distribution of the rainfall was generally uneven both as regards area and period, but in many areas the deficiency of rains in one month was counter-balanced by their abundance in the following months, with the result that the season on the whole was satisfactory. In SIND, however, due to the late and irregular inundation from the Indus, the season was only moderate.

In the CENTRAL PROVINCES the excessive and prolonged rain during the monsoon period resulted in a partial failure of the *kharif* crops except rice, while the absence of winter showers reduced the outturn of *rabi* crops.

In the PUNJAB the climatic conditions were not very favourable for the sowing and maturing of autumn crops, but proved generally beneficial to *rabi* sowings.

In the UNITED PROVINCES the belated monsoon and the excessive rains in September and October proved unfavourable to *kharif* crops except rice, but left abundant moisture in the soil which facilitated extensive sowing of *rabi* crops. The absence of winter rain reduced the outturn.

In BIHAR AND ORISSA the monsoon was on the whole favourable except in the north-west, where the heavy July falls damaged the cane and maize crops to a certain extent. The

failure of the rains during the growing season affected the *rabi* crops throughout Bihar.

In BENGAL the season was generally good for winter rice and satisfactory for autumn and spring crops, but high floods in the Brahmaputra towards the end of July caused wide-spread damage in the adjoining tracts.

In ASSAM the distribution of rainfall was generally irregular, the chief feature being excessive falls in April and May, which caused damage in low-lying areas.

In BURMA the season was somewhat unsatisfactory. In Lower Burma several of the delta districts suffered from severe floods which resulted in late planting of the paddy crop and the late rains were also insufficient over a large part of the area. In the dry zone the early rains were practically a failure and the cotton and sesamum crops were damaged over a wide area.

1932-33

The monsoon of 1932 was fairly normal and gave moderately well-distributed rains in spite of a rather weak start and a prolonged break in August. Averaged over the plains of India, the total rainfall during the monsoon period was only three per cent. below the normal, but the deficit was greater in Bihar, the east United Provinces and the north Madras coast. During the retreating period of the monsoon, the rainfall was in excess in Bengal, Bombay, Mysore, Assam, Bihar and Orissa, Punjab, Hyderabad and Madras, but defective elsewhere. Taking the year as a whole, the total rainfall was within 20 per cent. of the normal over most of the country. The season was generally favourable, and crops fairly good. The outturn of rice, though short of last year's plentiful harvest by 7 per cent., was quite good, being almost equal to the average of the preceding five years. Sugarcane gave a good yield which exceeded the previous year's record figure by 17 per cent. The outturn of cotton and sesamum increased by 12 and 14 per cent. respectively, and those of groundnut and castor seed by 25 and 1 per cent. respectively as compared with the preceding year.

Under restricted cultivation the production of jute amounted only to 7·1 million bales, which, though greater than the previous year's yield, was still even below the average production of the preceding five years. The wheat crop of 1931-32 was 3 per cent. less than that of the preceding season, but was slightly above the average of the preceding five years. The production of rape-mustard and linseed (winter oil-seeds) showed an increase of 4 and 10 per cent. respectively, as compared with the preceding season.

In Madras the South-West monsoon was below normal in all districts except Bellary, Coimbatore, Trichinopoly, Madura, Ramnad and Tinnevelly. The South-East monsoon was above average except in Kurnool, Cuddapah, Nellore and Chittoor.

In Bombay, in spite of uneven distribution of the rains, the season was fairly satisfactory. There was slight diminution in the acreage under food grains owing to the unsuitability of the sowing rains in some places, but later weather conditions proved favourable and fairly good yields were obtained. With the opening of the Lloyd Barrage Canal system both the area and outturn of crops in Sind were considerably greater than those of the preceding year or the average of the last ten years.

In the Central Provinces continued and excessive rainfall in the early monsoon lowered the outturn of all *kharif* crops, except rice. The short rainfall of the late monsoon, the total absence of winter showers in December and most of January, and thereafter cold and frost in the northern districts combined with hail and untimely rain at harvesting, reduced the outturn of *rabi* crops.

In the Punjab weather conditions were generally favourable for the sowing of autumn crops except cotton, but were not so satisfactory for their maturing. The dry weather during October, November and the first three weeks of December considerably reduced the *rabi* sowings. The light winter rains, though useful, were insufficient, while some rainfall accompanied by hail-storms in April and the beginning of May proved injurious to crops on the threshing floors.

In the UNITED PROVINCES the late appearance of the monsoon retarded *kharif* sowings in a number of districts, while its early cessation was responsible not only for loss in this harvest generally, but also affected *rabi* sowings adversely. Insufficient winter rains affected the *rabi* crops and unseasonable rains in April damaged the grain on the threshing floor.

In BIHAR AND ORISSA the season was distinctly unsatisfactory. The rainfall was generally below normal over the major part of the province and this together with an unequal distribution of the rains affected the rice crop adversely. Weather conditions were, however, generally favourable for the sugarcane crop.

In BENGAL the season was satisfactory for winter and spring crops and fairly favourable for autumn crops. The *rabi* sowings were somewhat reduced by defective rainfall in April but later conditions proved favourable.

In ASSAM the distribution of rainfall was generally uneven and irregular throughout the province, but there were no serious floods.

In BURMA the early rains were sufficient everywhere and well-distributed, but the late rains, particularly in Upper Burma, were disappointing. A break in the middle of August caused considerable anxiety in Lower Burma, but the rice crop there was more successful than in the previous year. Conditions in Upper Burma were variable, some districts having a good year and others a distinctly poor one.

2. ECONOMIC CONDITIONS.

The depression of trade and the fall in the prices of raw commodities which commenced in 1929 persisted during the period 1931-32. This reduction in prices of agricultural produce affected the purchasing power of India's vast agricultural population and was the cause of a heavy drop in the imports of manufactured goods and consequent fall in the customs revenues of the country. The table below gives the percentage decline in the Calcutta index numbers for the important

agricultural commodities in December 1930 and 1931, September and December 1932 and March and June 1933, as compared with September 1929.

Percentage decline in the index numbers on the basis of September 1929.

Commodity	December 1930	December 1931	September 1932	December 1932	March 1933	June 1933
Rice	25	40	53	55	58	48
Wheat . . .	47	36	31	34	34	36
Tea	11	47	55	56	46	27
Oil-seeds . . .	43	54	56	56	63	56
Jute (raw) . . .	50	36	44	58	58	58
Cotton . . .	53	34	35	39	46	40
Sugar . . .	22	10	12	15	23	21

It will be noticed that the heaviest declines in December 1930 were in cotton, jute, wheat and oil-seeds in decreasing order; in December 1931 in oil-seeds, tea and rice; in December 1932 in jute, oil-seeds, tea and rice; in March 1933 in oil-seeds, rice, jute and tea; and in June 1933 in jute, oil-seeds, rice and cotton. The fall has therefore not been uniform in the various agricultural commodities, and therefore the agricultural incomes of the various provinces have been affected differently.

During the period many cultivators found difficulty in meeting their financial obligations and their impoverished state reacted adversely on the wider and more general extension of agricultural improvements.

Imperial Economic Conference, 1932, and the Ottawa Trade Agreement.—An outstanding event of the period under review was the Imperial Economic Conference held at Ottawa in July 1932, at which delegates from the various Empire Governments, including India, were present. The principal business of the Conference was the negotiation of trade agreements between different countries of the Empire. The Indian Delegation had

to consider, in particular, the question whether, having regard to the new tariff policy which His Majesty's Government in the United Kingdom had adopted and to the new tariff preferences to Empire produce provided by the United Kingdom Import Duties Act, 1932, India should enter into a trade agreement with the United Kingdom for reciprocal tariff preferences so designed as to benefit the trade of both countries. The result of the Conference was the conclusion of a Trade Agreement between His Majesty's Government in the United Kingdom and the Government of India, in which a number of agricultural and allied commodities figured prominently. The Agreement was ratified by the Indian Legislature in December 1932.

Though their immediate insurance value is of the greatest importance during a period of stress in which all world markets for natural products show a contracting tendency, the ultimate value to the country of the preferences which had been secured on such agricultural commodities as linseed, castor seed, groundnuts, wheat, spices, tobacco, rice and vegetable oils will depend largely on the energy with which these new business opportunities are developed. The Imperial Council of Agricultural Research has been able to obtain and supply to provincial agricultural departments and others information regarding these new openings and of the position which Indian products occupy *vis a vis* those of the principal competing countries. Indian linseed, for example, already commands a premium for quality in the London Market and, as there is no Empire competition, should be able with the help of the ten per cent. tariff preference to capture a valuable trade, provided that adequate supplies at reasonable prices are forthcoming. In groundnuts the intrinsic quality of the Indian product is satisfactory but bad handling, especially damping and wet shelling, which lead to an excessive free fatty acid contents, cause the produce of certain areas to be discriminated against. This has been brought to the notice of the Provincial Governments and Agricultural Departments concerned. India's trade in tobacco with the United Kingdom is already a valuable one; with the aid

of the preference which has now been stabilised for ten years from 1932 it should be possible to develop it further, especially if suitable types of cigarette tobacco can be produced in larger quantity—as seems probable. Here and as in the case of some other commodities, the early starting of several research schemes now awaiting the allotment of funds would be of great advantage. In regard to nearly all Indian exports of agricultural products, better marketing, better handling and better grading is called for. The report of the Committee of the Imperial Economic Conference of 1932 on this subject shows clearly that India cannot afford to be left behind.

World Economic Conference, 1933.—Another event of international importance which might have affected India was the World Economic Conference, which assembled in London in 1933 with the object of reviving world trade. The hopes entertained in this Conference were not however fulfilled mainly on account of disagreements on monetary policy.

3. The Imperial Council of Agricultural Research.

The two years under review saw a marked development of the Council's activities. The latter part of 1929-30 had been mainly devoted to organisation and a survey of the position of agricultural research in India which extended well into 1930-31. April 1931 saw thirty agricultural and three veterinary live-stock research schemes in operation, the former number including the special sugar research schemes and the special provision of locust research. During 1931-32, sixteen fresh schemes were sanctioned and ten more during 1932-33. The total funds allocated to research schemes up to the end of 1932-33 was about 63 lakhs. In 1930, certain principles were laid down by the Governing Body of the Council to govern the allotment of research grants and these may briefly be re-capitulated. The Council's financial resources being limited, though substantial, it was decided that to qualify for a grant a research scheme should be of all-India importance, or that the problem which it set out to solve should be one affecting more than one pro-

vince and that the possibility of co-operation with other provinces should be explored. It was laid down that the expenditure proposed should not be in relief of normal provincial expenditure, that as a rule the necessary land and buildings should be provided by the Local Governments concerned and that, ordinarily, the Local Governments interested in a scheme should bear an appropriate share of the recurring expenditure. At the same time, the Governing Body decided that it would not lay down hard and fast rules in these matters, and that the extent to which the above conditions might be relaxed would depend on the importance of any particular project and the extent to which it was calculated to benefit the country as a whole.

From the outset it was made clear that applications for research grants need not be limited to the central, provincial and State agricultural departments, but that universities and non-governmental research institutions of suitable standing were entitled to submit proposals for consideration. It was naturally laid down that schemes of research from non-governmental institutions would be expected to have the support of the Local Government of the province; in practice all such schemes are reported on by the provincial agricultural research committees. The period 1931-33 was one of retrenchment and financial stringency and the Research Council bore its share of the burden in common with other departments of Government. Not only was a slowing-up in activities essential but staff was actually retrenched at a time when expansion was needed and, for a time, work was carried on with great difficulty. The annual grant of five lakhs made to the Council was suspended with effect from April 1932, but a supplementary grant of an equal amount was received later in the financial year. These measures of retrenchment, though they delayed the starting of approved schemes did not lead to any actual dislocation of work. This was largely due to the fact that the Government of India had made a lump sum grant of twenty-five lakhs (fifteen lakhs paid up) which protected the Council's

commitments, and also to the system adopted of providing for all schemes for a specific term of years and only sanctioning those schemes for which funds could be allotted up to completion.

The research work financed by the Council is referred to in detail in subsequent chapters of the review. The receipt of the annual research grant in the form of a supplementary grant late in the year caused some delay in the allocation of funds and the best summary of the position at the end of 1932-33 is to be found in the following table of research schemes in actual operation during 1933-34.

Statement showing the Research Schemes in progress during 1933-34.

Name of Scheme	Sanctioned grant
	Rs. A. P.
A.—Sugar Schemes.	
1. Sugar Technologist and Staff . .	1,66,100 0 0
2. (*a*) Sugar Cable Service . . .	40,900 0 0
(*b*) Indian Sugar Trade Information Service	34,100 0 0
3. Lump sum grants of Rs. 8,000 each to United Provinces, Bihar and Orissa and Punjab Governments for experiments in the designing of a satisfactory small-power sugarcane crushing mill. A further grant of Rs. 5,000 was sanctioned for the Punjab	29,000 0 0 (24,000 *plus* Rs. 5,000 extra grant to the Punjab)
4. Bombay-Deccan Sugarcane Research Scheme	5,22,000 0 0 (from 1931-32 to 1935-36)
5. Grant to Harcourt Butler Technological Institute, Cawnpore, for Sugar Technology . . .	2,25,000 0 0 (from 1930-31 to 1934-35)
6. Sugarcane Research Station in Bihar and Orissa and Sugarcane Specialist	1,92,800 0 0 (from 1931-32 to 1936-37)
7. Sub-station of the Coimbatore Imperial Sugarcane Breeding Station at Karnal	82,000 0 0 (from 1931-32 to 1935-36)

Name of Scheme	Sanctioned grant Rs. A. P.	
A.—Sugar Schemes—contd.		
8. Research on "Mosaic" and other Cane diseases at Pusa . . .	65,000 0 0 (from 1932-33 to 1934-35)	
9. Bengal Scheme for the improvement of sugarcane-crushing mills and gur-boiling	5,700 0 0 (from 1930-31 to 1934-35)	
10. Sugarcane Seedling Testing Station at Dacca	13,100 0 0 (from 1931-32 to 1935-36)	
11. Economic enquiry into the Cost of Production of Crops in the principal Sugarcane and cotton tracts in India	4,43,200 0 0 (from 1932-33 to 1935-36) 68,800 0 0 (from 1932-33 to 1935-36)	5,12,000
12. Research on Sugarcane in the Madras Presidency	1,50,100 0 0 (5 years)	
13. Sugarcane Research Station in the Punjab	1,33,000 0 0 (from 1933-34 to 1938-39)	
14. Sugarcane Research in the United Provinces	1,01,300 0 0 (from 1933-34 to 1938-39)	
15. Research and Testing Station for the indigenous system of *gur* and sugar under the Sugar Technologist to the Council	1,67,400 0 0 (5 years)	
16. Extension of sugarcane work at the Jorhat Experimental Station, Assam	48,000 0 0	
17. Investigation into the production of *khandsari* sugar in United Provinces and Bihar and Orissa . .	9,000 0 0	
B.—General Agricultural Schemes.		
18. Grant to Dr. K. C. Mehta for investigation of rusts of wheat and barley (See 23)	41,432 13 10 (from 1929-30 to 1932-33)	
19. Botanical Sub-station at Karnal .	1,33,900 0 0 (from 1930-31 to 1934-35)	

Name of Scheme	Sanctioned grant Rs. A. P.
B.—General Agricultural Schemes —contd.	
20. Grant to Dacca University (Soil Investigations)	39,800 0 0 (from 1930-31 to 1935-36)
21. Research into the properties of Colloid Soil-constituents (under Professor J. N. Mukerjee, Calcutta University)	14,100 0 0 (from 1931-32 to 1935-36)
22. Investigation on experimental errors in field trials. Statistical studies relating to Agricultural work in India (under Professor Mahalanobis, Calcutta University) . .	51,500 0 0
23. Investigation into the rusts of wheat and barley at the Agra College, Agra	54,600 0 0
24. Investigations on:—	
(*a*) Effects of ions on plant growth	8,000 0 0 (from 1930-31 to 1934-35)
(*b*) Physico-chemical properties and fertility of soil (under Professor Bhatnagar, Punjab University, Lahore)	10,700 0 0 (from 1931-32 to 1934-35)
25. Research on the physiology of the rice plant (under Professor Dastur, Royal College of Science, Bombay)	10,800 0 0 (from 1931-32 to 1933-34)
26. 'Wither-tip of citrus trees' (under Dr. Chaudhri, Punjab University, Lahore)	13,800 0 0 (from 1931-32 to 1934-35)
27. Agricultural Meteorology (under the Indian Meteorological Department, Poona)	61,600 0 0 (from 1932-33 to 1935-36)
28. Appointment of a Physical Assistant on the staff of the Agricultural Chemist, Bengal	22,600 0 0 (from 1931-32 to 1935-36)
29. Co-ordinated scheme of Rice Research in seven Provinces . . .	10,96,400 0 0 (from 1931-32 to 1935-36)

Name of Scheme	Sanctioned grant Rs. A. P.
B.—General Agricultural Schemes —concld.	
30. Special Locust Research staff . .	3,60,200 0 0 (from 1930-31 to 1934-35)
31. Grant to the Punjab Government for locust research	12,000 0 0
32. Locust Bureau	38,200 0 0
33. Experimental consignment of mangoes to the Empire Marketing Board	9,544 13 9
34. Research work on potatoes in Madras	20,000 0 0 (from 1933-34 to 1937-38)
35. Mechanical cultivation (part cost of experiments by the Burmah Shell Company)	7,000 0 0
C.—Animal Husbandry Schemes.	
36. Goat breeding (under Dr. Slater, Etah)	33,500 0 0
37. Veterinary Investigation Officers in provinces:—	
(i) Bombay	50,000 0 0
(ii) Bengal	50,000 0 0
(iii) Punjab	50,000 0 0
(iv) Bihar and Orissa . .	50,000 0 0
(v) Central Provinces . .	50,000 0 0
(vi) Madras	50,000 0 0
(vii) United Provinces . .	50,000 0 0
(viii) Assam	50,000 0 0
(ix) Hyderabad . . .	50,000 0 0
38. Appointment of a Physiological Chemist to study animal nutrition at Dacca	48,600 0 0
39. Investigation into the most suitable and economic methods of combating different types of parasitic infection in ruminants in the fields, etc., in the Punjab . . .	20,100 0 0
40. Appointment of a Statistician for the compilation of certain statistics relating to feeding-scales, etc., in the Military Dairies (at the headquarters of the Council) . .	7,800 0 0

Amongst the miscellaneous activities of the Council during these two years may be mentioned the first meeting of the Animal Husbandry Wing of the Board of Agriculture and Animal Husbandry, which was held in Delhi in February 1933, the putting into operation of the recommendations of the Fertilisers Committee for a review of fertiliser experiments throughout India, the results of which have since been published, and an enquiry by Mr. T. S. Sabnis, who was placed on deputation under the Council, into hemp-growing and marketing in India. The survey resulted in practical recommendations for the improvement of Indian hemp which have been taken up by the agricultural departments concerned, and it has been reported that there has been a distinct improvement in the quality of the Indian hemp arriving in the United Kingdom. An Oil-Seeds and Oil-Crushing Industry Committee was set up and met for the first time in May, 1931. This Committee made a number of recommendations for encouraging the development of the oil-crushing industry in India and arranged for the dissemination of useful information regarding defects in the present trade. It also examined all the schemes of research on oil-seeds which came before the Council and, as a result of its recommendations, a grant was subsequently given to the Oil Technology Section of the Harcourt Butler Technological Institute.

The Government of India's contribution to the International Institute of Agriculture, Rome, is made annually through the Imperial Council of Agricultural Research, which also arranges for the Indian delegation at the biennial meetings of the General Assembly of the Institute. At the General Assembly Meeting, 1932, India was represented by Sir Bhupendra Nath Mitra, High Commissioner for India in London, who was elected President of the General Assembly for that session. Sir Bhupendra Nath Mitra is also the representative of India on the Permanent (International) Committee, which is the managing body of the Institute.

At the World's Grain Exhibition and Conference held in Canada in 1933, India was represented by the Indian Trade

Publicity Officer, Mr. B. D. Asli, whose services were made available by the High Commissioner for India in London. The Indian national exhibit for this important exhibition and conference was organised by the Imperial Council of Agricultural Research with the co-operation of the several departments of agriculture in India, the Director of the Imperial Institute of Agricultural Research, the Indian Central Cotton Committee, the Indian Tea Cess Committee and a number of unofficial contributors.

CHAPTER II.

ECONOMIC WORK ON CROPS.

The production and introduction into general cultivation of improved varieties of crops is one of the most important functions of the agricultural departments in India. Improvement may lie in superior quality or in a heavier-yielding capacity, or in disease-resistance and better adaptability to environment, thus ensuring greater regularity in quality and yield. Usually the improved variety chosen for introduction combines several of these advantages, but it may be remarked that when a pure-line selection does not surpass the mixed crop in intrinsic yielding power and quality, it is likely to command a premium on account of the increased uniformity of the product resulting from the uniformity of the length of the life-cycle, *i.e.*, time of ripening.

Within the limits of this Chapter it is not possible to do more than touch briefly on the main lines of the improvements effected; the investigations which form the basis of these improvements are dealt with more fully in a subsequent chapter.

The ascertained area under improved varieties of crops in British India in 1931-32 was approximately 14·4 million acres and in 1932-33 15·4 million acres, as compared with 12·5 million acres in 1930-31. In other words, the recorded area under improved crops has increased by 22·7 per cent. in the course of the last two years. As has been explained in previous reviews, these figures are invariably under-estimated due to the impossibility of ascertaining the full extent of the 'natural spread' of improved varieties once they become popular. To this statement there is one exception. The area under improved kinds of sugarcane in the United Provinces has been actually recorded by village accountants. The following tables give the position so far as it can be ascertained.

TABLE I

Area under improved crops in India in 1931-33 (in acres) (so far as information is available)

Province or State	RICE		COTTON		WHEAT		JUTE		SUGARCANE		OTHER CROPS	
	1931-32	1932-33	1931-32	1932-33	1931-32	1932-33	1931-32	1932-33	1931-32	1932-33	1931-32	1932-33
British India												
Madras	399,492	564,379	340,986	351,390	..	..	..	..	25,221	24,800	140,869	139,663
Bombay Presidency Proper	33,606	86,593	658,565	570,551	30,551	20,526	..	..	379	5,122	742,176	862,415
Sind	3,000	8,888	161,326	208,675	103,247	173,937	..	..	..	..	636	700
Bengal	284,193	303,517	..	..	..	..	928,870	957,711	66,681	98,172	2,292	4,136
United Provinces	..	..	271,000	305,000	1,940,000	2,096,000	..	..	1,188,000	1,290,000	269,000	357,000
Punjab	..	..	1,234,370	1,355,460	2,771,880	2,515,300	..	..	142,840	174,770	..	..
Burma	489,031	668,748	9,540	2,826	15,726	13,571	..	..	1,732	3,342	166,432	192,991
Bihar and Orissa	22,236	21,306	..	..	35,846	37,907	273	476	194,705	230,025	11,162	17,617
Central Provinces	336,267	400,281	588,169	396,765	427,992	458,932	..	..	..	..	270,104	346,233
Assam	22,875	36,841	..	..	..	..	41,854	45,090	7,578	8,851	13,494	14,226
North-West Frontier Province*	..	..	..	..	..	..	..	..	..	..	..	..
TOTAL FOR BRITISH INDIA	1,590,700	2,090,553	3,263,956	3,190,667	5,325,242	5,316,173	970,997	1,003,277	1,627,136	1,835,082	1,616,165	1,934,981
Indian States												
Hyderabad	..	..	197,213	194,675	..	..	..	..	34	45	543	2,237
Mysore	47,247	51,419	40,900	51,648	..	..	..	..	3,746	8,138	205,046	232,622
Baroda	8,403	8,422	19,172	29,963	2,604	6,149	..	..	..	..	..	60
Travancore	880	2,000	..	..	..	..	..	..	..	..	..	..
TOTAL FOR INDIAN STATES	56,530	61,841	256,785	276,286	2,604	6,149	..	..	3,780	8,183	205,589	234,919
GRAND TOTAL FOR BRITISH INDIA AND INDIAN STATES	1,647,230	2,152,394	3,520,741	3,466,953	5,327,846	5,322,322	970,997	1,003,277	1,630,916	1,843,265	1,822,154	2,169,900

* The Agricultural Officer reports that no correct figures are available. No figures were supplied for 1930-31 also.

TABLE II

Areas under improved crops in India (so far as information is available)

Crop	BRITISH INDIA			INDIAN STATES			GRAND TOTAL FOR BRITISH INDIA AND INDIAN STATES		
	1930-31	1931-32	1932-33	1930-31	1931-32	1932-33	1930-31	1931-32	1932-33
Cotton	3,199,176	3,263,956	3,190,667	302,263	256,785	276,286	3,501,439	3,520,741	3,466,953
Wheat	5,025,889	5,325,242	5,316,173	356,750	2,604	6,149	5,382,639	5,327,846	5,322,322
Rice	1,247,717	1,590,700	2,090,553	39,581	56,530	61,841	1,287,298	1,647,230	2,152,394
Sugarcane	1,058,043	1,627,136	1,835,082	6,439	3,780	8,183	1,091,482	1,630,916	1,843,265
Jute	1,104,997	970,997	1,003,277	..	..	..	1,104,997	970,997	1,003,277
Groundnuts	144,877	881,096	1,005,053	106,346	47,171	50,570	250,624	928,267	1,055,623
Millets †	155,447	123,459	147,405	133,666	151,990	176,617	289,113	275,449	324,022
Gram †	222,203	227,295	248,035	..	..	..	222,203	227,295	248,035
Potatoes †	13,275	7,778	9,883	..	..	..	13,275	7,778	9,883
Other crops †	361,786	376,587	524,605	12,996	6,428	7,732	374,782	382,965	532,337
TOTAL	12,533,410	14,394,196	15,370,733	958,041	525,288	587,378	13,517,852	14,919,484	15,958,111

† Not separately reported by some Provinces.

1. Rice.

On an average rice occupies some 35 per cent. of the total cultivated area in India, and the following table shows the estimated area and yield during the last three years:—

Year	Area in acres	Tons of paddy
1930-31 . . .	82,846,000	32,198,000
1931-32 . . .	84,374,000	33,001,000
1932-33 . . .	82,518,000	31,002,000

A good yield was obtained for the rice crop of 1931-32 except in Burma; and the total production exceeded the previous year's plentiful harvest by two per cent. The crop of 1932-33, though seven per cent. short of the previous year's record outturn, was quite good, being almost equal to the average of the preceding five years. In Bihar and Orissa and the United Provinces the crop was affected by insufficient rains.

The exports of rice and paddy represent seven and six per cent. of the total production in 1931-32 and 1932-33, respectively:—

Exports in thousands of tons.

Year	Rice	Paddy
1930-31	2,254	25
1931-32	2,301	70
1932-33	1,828	59

In 1931-32, Burma's share of the total exports was 90 per cent., as compared with five and three per cent. respectively for Bengal and Madras. The respective percentages for 1932-33 were eighty-eight, six and four.

During 1931-32, prices reached a disastrously low level as compared with those of the preceding year, whilst in 1932-33 prices declined further. This unprecedented fall in prices was largely due to the general economic depression which affected the prices of all agricultural commodities; the rice trade in addition had its peculiar difficulties during the period. Coastwise shipments of rice and paddy from Burma to India proper amounted to 1,086,000 tons in 1931-32 and to 936,000 tons in 1932-33. The total area under improved varieties of rice has

steadily increased from 1,247,717 acres in 1930-31 to 1,590,700 acres in 1931-32 and to 2,090,553 acres in 1932-33.

A brief description was given in the last review of the co-ordinated scheme of research work on Indian rices which the Imperial Council of Agricultural Research, with the financial assistance of the Empire Marketing Board, and the co-operation of the principal rice-growing provinces, was able to inaugurate. During the period under review work has been started under the scheme in all the provinces, except Assam where land for the experimental farm was not obtained until the following year.

MADRAS. This Presidency has about 14 per cent. of the total area under rice in India and produces about 17 per cent. of the total Indian crop :—

Year	Area in acres	Production in tons	Area under improved strains in acres
1930-31 . .	11,678,000	5,376,000	292,478
1931-32 . .	11,538,000	5,385,000	399,492
1932-33 . .	11,534,000	5,406,000	564,379

The improved strains and the bulk selections which have been issued by the Department in previous years are spreading all over the province, and the area under them is steadily mounting. The variety known as G.E.B. 24, in particular, is reported to be increasing in popularity on account of its cosmopolitan qualities. It is making considerable headway, especially in Malabar and the Ceded Districts. In spite of the low prices and the reduced demand, an extra profit of Rs. 10 is easily obtained for this variety owing to its superior quality and high cropping power.

Steady progress has been maintained in the matter of seed distribution, the total amount of seed distributed by the Department alone going up to 280 tons in 1932-33, as compared with 200 tons in 1931-32 and 160 of 1930-31. In addition, a number of seed-farms, on ryot's land under departmental supervision, produced seed sufficient for 300,000 acres.

Work on the improvement of paddy was continued at Coimbatore, Maruteru, Aduturai and Pattambi, and a new Rice Research Station has been opened at Berhampur as the

result of a grant by the Imperial Council of Agricultural Research. At Coimbatore, an Aneikomban strain, which proved very promising in the last five years' trials, is ready for distribution to ryots; and has since been released under the name of Co. 8. Two more promising strains of Samba and two of Kar will be available for distribution shortly. As the result of a series of trials with important Kistna and Godavari varieties, eight superior types are being released from Maruteru under the designation of M.T. 01-8. A high-yielding strain from Korangu Samba was released from Aduturai under the name of Adt. 10. Two strains, Adt. 9 and 11 are in the trial plots and appear promising. Fourteen strains have passed through the preliminary stage at Pattambi and will be ready for extended trials next year. Over 2,000 single plant selections have been made at the new Rice Research Station, Berhampur.

The research work at Coimbatore includes work directed to the production of types resistant to 'foot-rot' and 'blast' of paddy. Eleven strains resistant to the 'blast' disease have been obtained from the cross G.E.B. 24 Korangu Samba, while among 40 varieties representing all the important paddy tracts of South India, there are some which are practically immune to 'foot-rot'. A study of the inheritance of characters has confirmed that sterility of grain is frequently associated with a non-lodging straw, and that there is no intimate relationship between the number of tillers and yield.

Experiments conducted at Coimbatore, Maruteru and Pattambi for two years to ascertain the optimum time for applying a quick-acting manure like ammonium sulphate has shown that at Maruteru and Pattambi it is best applied one month after planting, but two months after planting at Coimbatore. Trials on the value of intensely manuring the seed-beds have proved the manuring of the transplanted field to be of greater importance than that of the seed-bed.

In view of the very low prices realised for paddy, trials of substitute crops were made at all paddy stations. Among the

crops tried were sugarcane, plantains, *ragi*, gingelly, fodder, sorghum, groundnut and Cambodia cotton. Several of them were hopeful but the most promising results have been obtained at Maruteru with Cambodia cotton which was raised in December and irrigated for two months. As canal water which is now running to waste is available for just those two months, there appears to be scope for the cultivation of cotton after paddy in that area.

BENGAL. On the average of the last three years Bengal has 25·8 per cent. of the total area under rice in India and produces 29·1 per cent. of the Indian crop :—

Year	Area in acres	Yield of paddy in tons
1930-31 . . .	20,582,000	9,206,000
1931-32 . . .	22,129,000	9,943,000
1932-33 . . .	21,771,000	9,361,000

Special attention was paid as usual to the propagation of the departmental varieties, as is evidenced by the increase in the area under them which stood at 303,517 acres in 1932-33 as against 223,233 in 1930-31. During 1931-32 there were 245 seed centres, covering 8,200 *bighas*, growing departmental paddy. The total amount of seed supplied by these seed centres as well as by Government Farms was 13,818 mds. During 1932-33, there were 228 seed centres covering 8,877 *bighas* and the quantity supplied was 15,547 mds.

In addition to the *aus* strains known as Kataktara, Surajmukhi and Charnak, already widely distributed and cultivated over large areas, the department has recommended three new strains for East Bengal, *viz.*, Kumri, Dhairal and P. S. 8, the last being an early hybrid suitable for double-cropped land. Dhairal is a coarse variety and has done particularly well in East and North Bengal. Two strains called Jhanji and Bhutmari 36 have been recommended for West Bengal conditions. In addition to Indrasail, Dudsar and Jhingasail of the *aman* group, already under distribution, the department has recommended Nagra 68, Chinsura No. 2 and Chringribusi No. 5, all of them very good performers in the different tracts

for which they are recommended. Economic work on rice is in progress at five centres, *viz.*, Dacca, Barisal, Chinsura, Bankura and Suri. The work at Chinsura and Bankura is aided by a grant from the Imperial Council of Agricultural Research.

Experiments carried out on the various farms to ascertain if a lesser dose of Niciphos can be applied to seed-beds, without affecting the results, have shown that the application of 100 lbs. per acre hastens the maturity of the seedlings from 7 days to 3 weeks, a result of particular value in cases where seed-beds are sown late or have to be re-sown owing to damage or other causes. Applications of ammonium phosphate to transplanted *aman* paddy have given good results on the poorer types of soil, but at the present price of paddy this is not an economic proposition. By a series of analyses of plants raised in sand-culture with the application of different manures, it was observed that a shortage of any plant-food was not evident in the grain, but that in the grain of those plants lacking a nitrogen dressing, there was a much higher percentage of silica. A study of the nitrogen-phosphate ratio for paddy nutrition on red soils showed 1 : 2½ as the best ratio for *aman* paddy and 1 : 3 for *aus* paddy.

BIHAR AND ORISSA. On the average of the last three years, rice occupies in Bihar and Orissa 16·4 per cent. of the total area under the crop in India and contributes 16·2 per cent. of the total crop :—

Year	Area in acres	Yield in tons
1930-31 . . .	13,927,000	5,615,000
1931-32 . . .	14,091,000	5,738,000
1932-33 . . .	13,072,000	4,201,000

The lower area in 1932-33 was due to the unfavourable weather conditions in Bihar, where the area under winter rice amounted to only 9,700,000 acres, compared to a normal of 10,750,000 acres. The area under improved varieties stood at 21,306 acres in 1932-33 as against 15,134 acres in 1930-31. In Bihar proper, the departmental selection, Dahia has repeatedly proved its superiority over corresponding medium-early varieties, both in respect of yield and drought-resistance. It

has now spread fairly extensively throughout South Bihar. Among the medium and late types, Kanke II and Latisail are so far the best varieties for Bihar, whilst for Chota Nagpur, Kankesal and Latisail have remained unbeaten. It has been definitely established that both Dahia and Cuttack I can be grown with complete success as a *dalua* paddy and are in many respects superior to the local types. It has also been established that it is not necessary to grow either variety as an *aus* (early or Autumn) crop before it can be used as a *dalua* paddy. These facts are of great practical importance, for the *dalua* paddy crop is essentially a catch crop and of special importance in parts of Orissa in those years when the main paddy crop has been destroyed by abnormal floods. Such occurrences are unfortunately not infrequent and the knowledge that large quantities of seed of these varieties can confidently be distributed for sowing simplifies the flood relief problem. At the Kujang Farm a promising flood-resistant variety has been isolated and is under trial. Work has also been started on the isolation of varieties tolerant to saline conditions.

Since the establishment of the Rice Research Station at Sabour with the financial help of the Imperial Council of Agricultural Research in January 1932, work on rice breeding has been transferred to that Station and is carried on by the Rice Specialist. In view of the varying conditions of soil and rainfall obtaining in the province, a sub-station for Orissa has been provided at Cuttack, and another will be opened at Ranchi on the Chota-Nagpur Plateau. Subsidiary stations have also been proposed for North Bihar and the black-soil tracts of South Bihar. The work in progress falls under four heads. On the botanical side, a detailed survey of the provincial types has been made and a study of their characters is being pursued. Agricultural investigations include finding the appropriate age of seedlings, the advantages of transplanting over broadcasting and the laying out of varietal and manurial experiments. Studies were started only in September 1932 on the dormancy and viability of rice seed. On the genetical side, a study of the details of the crossing technique is being made. Applications of artificial fertilizers

on some soils, notably those of the Cuttack Farm, had been found in the past to have practically no effect on paddy yields, but the continued application of lime to such soils has resulted in modifying the sub-soil conditions in such a way that by the use of fertilizers big yields are now obtained.

BURMA. On the average of the last three years Burma had 15·3 per cent. of the total Indian rice acreage, and the production amounted to 14·7 per cent. of the total Indian output :—

Year	Area in acres	Yield in tons
1930-31 . . .	13,022,000	5,143,000
1931-32 . . .	12,517,000	4,202,000
1932-33 . . .	12,702,000	4,919,000

The area under improved types rose from 436,804 acres in 1930-31 to 489,031 acres in 1931-32, and jumped to 668,748 acres in 1932-33. That the department has made considerable progress in the matter of seed distribution is evident. This was largely due to the policy of opening seed-farms for paddy on the areas excluded from village grazing grounds. In addition to the twenty major seed-farms, the department maintained 124 ' grazing ground seed-farms ' in 1931-32 and 132 in 1932-33, as against 107 in 1930-31. The total amount of paddy seed distributed from all sources was 11,560,409 lbs. in 1932-33 and 10,564,256 lbs. in 1931-32, as compared to 8,873,590 lbs. in 1930-31. With a view to obtaining the latest information regarding the markets to which Burma is at present exporting its paddy and the types in greatest demand, the Director addressed a questionnaire to the four Chambers of Commerce in Rangoon which elicited the opinion that the main demand was still for the Ngasein type and to a lesser extent for the Emata type. The question of translucence of the grain did not appear to be of such great importance as good milling quality and outturn. The work on the improvement of Burma rices is conducted at five stations; at Mandalay for Upper Burma and at Hmawbi, Akyab, Myaungmya and Mudon for Lower Burma. The establishment of a Central Rice Research Station at Hmawbi with the financial assistance of the Imperial Council of Agricultural Research, and the Empire Marketing Board, has

enabled attention to be concentrated on paddy improvement, and to the work carried on for the last six or seven years to be accelerated and intensified.

The principal centre for paddy-breeding work was Hmawbi where the Rice Research Officer and the Assistant Rice Research Officer are stationed. The work in progress included the study of hybrid cultures, derived from crosses between local strains or between local and exotic strains; study of sub-tropical rices from Japan, Formosa, China and America. Genetical studies on several characters including grain and endosperm characters, sterility, albino and viriscent seedlings; growth studies with the object of analysing the factors determining yield, the effect of soil and climatic conditions on the quality of rice, the effect of different methods of drying and storing grain on the quality and milling behaviour of rice; and yield tests of new cultures.

The work for Upper Burma is in charge of the Economic Botanist. As a result of breeding work at the Mandalay Station, thirteen new varieties have been handed to the district agricultural officers for further multiplication and distribution. Breeding work on several other varieties is in progress. In the course of the investigation it was discovered that temperature has a great effect on the breakage of rice in milling, and to enable comparative milling tests to be made a special machine has been designed by the Economic Botanist. Germination tests with paddy at Hmawbi showed that germination capacity reached its maximum about five months after harvest and after that diminished to zero in six months' time. Some attention has been given at both the Hmawbi and Myaungmya Farms to the production of improved varieties of paddy suitable for flooded lands. At Hmawbi also it was found that although some of the new synthetic fertilizers of the ammonium phosphate type give a small profit per acre, the amount is not enough to warrant the cultivator spending money when paddy prices are low. It is however a paying proposition to apply manures to the nursery plots, and under present conditions profits of about Rs. 6 per acre can be obtained. The result of the per-

manent manurial experiments at Mandalay (which have been examined by the Research Council's Statistician) show that for this tract the best manures for paddy are either cattle manure or in the form of ammonium sulphate. As before, the new nitrogen-phosphate manures gave excellent returns in regions of moderate rainfall but the results at Akyab and Moulmein were negative, the cause being the actual washing out of the manures.

In the BOMBAY PRESIDENCY proper, rice occupied 2,026,678 acres in 1932-33, as against 1,976,245 acres in 1931-32 and 1,990,977 acres in 1930-31. The total outturn rose from 869,281 tons in 1930-31 to 903,054 tons in 1931-32 and to 907,204 tons in 1932-33. The agricultural department's seed-supply activities are mainly concentrated in the Konkan Division. The new system of seed distribution introduced in 1928-29 consisted in appointing ten registered seed-growers for each area, to whom seed of improved strains was supplied at half the market rate on condition that the department was allowed to rogue the standing crop and that the best half of the produce was made available for seed at the market rate. In 1931-32, there were 75 seed-growers in the Thana and Colaba districts, with an aggregate area of 550 acres sown with 16,820 lbs. of improved Kolamba rice. About 300,000 lbs. of seed was actually distributed through a number of private and official agencies. For the Ratnagiri district seed for sowing 1,000 acres was made available. In 1932-33 about 605,000 lbs. of seed were made available for cultivators in this manner, and the total area under improved varieties was estimated at 86,593 acres. Rice improvement work was continued at four centres, *viz.*, Karjat in the Colaba district, Ratnagiri in the Ratnagiri district, Kumpta in the Kanara district and Mugad in the Dharwar district. At Karjat, the strains K 42 and K 266 continue to be the best late Kolamba varieties, the former being a high yielder and the latter a fine variety fetching a premium. Six early varieties are in the trial stage. At Mugad, four improved strains of Mugad rice and three of Antesal rice have been produced. Two early strains and two late strains have been found promising at

Kumpta. Two intermediate strains, Panwel No. 6 and Waksal No. 207, are under distribution from the Ratnagiri Farm to seed-growers; in addition, several early and late strains have proved promising. Experiments at Karjat to determine the most economical amounts of sulphate of ammonia and the best time for its application have shown that the better results are obtained when the manure is applied at the pre-flowering stage than at the tillering stage and that one dose can be applied at the flowering stage also. It is stated that ammonium sulphate tended to decrease the protein content of rice, and that this could not be corrected by the addition of phosphatic manures. The addition of lime raises the protein content of rice and also corrects the acidity of the soil. Niciphos was not found superior to ammonium sulphate as a fertiliser for rice.

The area under rice in SIND dropped from 1,269,439 acres in 1930-31 to 1,182,963 acres in 1931-32 and to 1,108,485 acres in 1932-33. There was a corresponding fall in outturn from 540,273 tons to 524,610 tons and again to 447,558 tons. The multiplication of improved seed through the agency of co-operative organisations was continued. In addition, a system was introduced in 1931 of giving out annually small quantities to selected zamindars for multiplication on their own lands, the produce if satisfactory to be retained as seed for the next season. In 1931-32, in addition to 2,100 mds. of seed supplied from Government Farms and Development Associations, small quantities were supplied to 58 zamindars for multiplication. In 1932-33, 5,406 mds. were supplied from Government farms and by registered seed-growers; and 514 mds. of the Kangni 27 and Sugdasi varieties were distributed to zamindars who made available 3,745 mds. of seed from the produce. The area under improved rices has thus risen from 2,890 acres in 1930-31 to 8,888 acres in 1932-33.

Trials with acclimatised varieties from the Philippines, United States of America and Europe have shown that under North Sind conditions they are not superior to the improved Kangni and Sugdasi varieties which the department has already evolved on the Larkana Farm.

Kangni 27 appears suited to Lower Sind conditions also, but experimental shipments of Kangni rice to England brought out the fact that this variety is not suited to the London market. Evolution of suitable varieties for this purpose is being undertaken. Certain strains in the F_4 generation of the cross Kangni 27 × Kolamba 184 are promising. The possibility of advancing the period for transplantation of rice seedlings has grown in importance with the advent of a perennial water-supply under the Lloyd-Barrage, and early transplantation trials have proved a distinct success.

In the CENTRAL PROVINCES the area under rice fell from 5,541,000 acres in 1930-31 to 5,527,000 acres in 1931-32, but rose again to 5,595,000 acres in 1932-33, while the yield rose from 1,404,000 tons to 1,772,000 tons and fell again to 1,660,000 tons in the three corresponding years. The area under improved varieties steadily rose from 254,781 acres in 1930-31 to 336,267 acres in 1931-32 and to 400,281 acres in 1932-33. The number of private seed-farms organised by the Department for the multiplication of departmental paddies was 3,373 in 1931-32 and 3,678 in 1932-33, as compared with 2,850 in 1930-31. The quantity of paddy seed distributed was 135,831 mds. in 1931-32, and 138,840 mds. in 1932-33, as compared with 129,782 mds. in 1930-31. The demand for improved strains was especially keen in the Eastern Circle where the area under improved strains reached a figure of 234,723 acres in 1932-33. The varieties Surmatia and Ludko, which have been added to the list of standard varieties, have given satisfaction.

The work on the improvement of paddy has been continued. The hybrids produced by crossing well-established local varieties have now been fixed and they have proved better yielders than their parents. In addition, they possess the advantage of being easily distinguishable from the wild races. The cross Bhondu × Parewa gave an yield of 2,800 lbs. per acre. Some success has also been achieved in crossing the standard varieties Luchai and Bhondu, the object being to combine the strength of straw of the former with the high cropping power of the

latter. This crop presented technical difficulties owing to the two varieties possessing different flowering seasons.

On the establishment of the Rice Research Station at Raipur with the financial assistance of the Imperial Council of Agricultural Research, the breeding work hitherto carried on by the Second Economic Botanist has been transferred to that Station and a Botanist and a Biochemist have been appointed.

The Agricultural Chemist's Section has published the results of a study of some of the factors controlling the growth of rice in heavy soils. The results indicate that when a heavy soil which has been growing a *rabi* crop without irrigation is brought under rice, there is a decrease in the lime content of the soil and a change in its reaction. An application of green manure and a dressing of sulphur to such soils gave an increased outturn.

There was a steady increase in the area under rice in ASSAM from 4,652,000 acres in 1930-31 to 4,700,000 acres in 1931-32 and to 4,871,000 acres in 1932-33, and the yield increased in proportion from 1,366,000 tons to 1,589,000 tons and 1,677,000 tons in the respective years. The area under improved strains increased from 18,950 acres in 1930-31 to 22,875 acres in 1931-32 and to 36,841 acres in 1932-33. The seed-depôts at Gauhati, Jorhat and Sylhet supplied on the whole 1,962 mds. of paddy seed in 1932-33, and 1,490 mds. in 1931-32. Experimental work on rice was continued at Karimganj and Titabar Farms, mainly on the lines of selection and cross-fertilization. Apart from twenty recommended types in *Aus*, *Sail* and *Asra* groups given out from the Karimganj Farms as a result of pure-line selection, a new type C/148/1 (*Chengri Aus*) has been recommended to the cultivators. The *Sail* variety Badshabhog has established its superiority over others. Among *Sail* races, Kerr Sail, a cross-bred variety did better than other selections. A variety known as Lakshmi Joha, a fine *Sail* paddy, will be ready for distribution in the ensuing season. The manurial experiments with *dhaincha* and sann-hemp seemed to give better residual effect when accompanied with liming than without it. Preserved cow-dung gave better residual effect than ordinary cow-dung. The cultural trials included the investigation of the most suit-

able age of seedlings for transplantation, economic seed-rates for *Sail* and *Aus* paddies, broadcasting *vs.* transplantation, and the advantages of winter ploughing. The study of the milling and cooking qualities was continued.

In the UNITED PROVINCES, rice occupied an area of 6,119,000 acres in 1932-33, as against 6,555,000 acres in 1931-32 and 6,722,000 acres in 1930-31. The outturn increased from 1,704,000 tons in 1930-31 to 1,989,000 tons in 1931-32, but shrank to 1,322,000 tons in 1932-33. The Economic Botanist has already made a study of the provincial types and devoted attention to the production of a high-yielding paddy, resistant to *Leptocorisa varicornis* (*gundhi*). The Nagina Research Farm has been developed into a Rice Research Station as part of the All-India Research Scheme financed by the Imperial Council of Agricultural Research, and is devoting attention to the provision of pure seed of strains suited to different localities and to the accumulation of reliable data on the cultivation of the economic manuring of the crop. The development of higher-yielding and better-quality, early paddies is necessary for the Sarda area. Research has progressed in different directions, the most important of which is the hybridization work aiming at the combination of the enclosed-ear habit of the coarse broadcast rice, Sathi, with a high-yielding and finer variety, with a view to protecting the latter from the attacks of *gundhi*. Observations on the F_3 generation show that some promising selections may combine the desired characters. Fundamental studies include the inheritance of distinguishing colour characteristics and cytological work on pure strains and hybrids.

Rice occupies the comparatively small area of 799,000 acres in the PUNJAB. As the outcome of a number of inter-varietal yield tests, four selections of different groups have been placed on the seed-distribution list. These are John No. 349, Basmati No. 370 and Mushkan Nos. 7 and 11. The supply of pure seed during the 1933-34 season was expected to cover an area of 28,000 acres.

In the HYDERABAD STATE, where rice was grown in 1932-33 on an area of 987,000 acres, the Economic Botanist has a number

of selected late and early types under study. Two of the early types have been found to be decidedly superior to the ordinary local varieties and have been successfully demonstrated in the villages.

The total area under rice in the MYSORE STATE is reported to have risen to 769,000 acres in 1932-33 from 731,000 acres in 1931-32. The area under improved varieties, of which G.E.B. 24 continues to be most popular, was estimated at 38,159 acres in 1930-31. Work at the Nagenhalli Paddy Breeding Station has resulted in the introduction of three new strains which have all proved better yielders than G.E.B. 24. These strains have now been distributed. At the Marthur Farm which caters for the Mulnad area, three pure varieties of high-yielding capacity are being multiplied for seed purposes.

Of the total area of 696,474 acres under rice in the TRAVANCORE STATE, some 2,000 acres were occupied by improved strains in 1932-33. Improvement work on paddy is mainly confined to the varieties known as *Samba* and *Valasiramundan*, two of the most important paddies in Nanginad. Selections have been made from these for alkali-resistance, non-lodging and high yield; 20,292 lbs. of seed of these selections were sold to ryots in 1932-33. A study of the tillering capacities of the different varieties is in progress.

In the BARODA STATE the area under rice was 226,000 acres, of which about 8,000 acres were under improved strains. Kolamba 42 strain is slowly extending and replacing the local types. K 226 and 184 are more recent selections which are reported to be promising.

2. Wheat.

On an average, wheat occupies 10 per cent. of the total area under cultivation in India. The estimated area and yield of wheat during the last three years are noted below :—

Year	Area in acres	Yield in tons
1930-31 . . .	32,189,000	9,306,000
1931-32 . . .	33,803,000	9,024,000
1932-33 . . .	32,973,000	9,440,000

India's present production of wheat is approximately equal to her requirements, and both exports and imports of wheat during the last three years were on a limited scale :—

Year	Exports in tons	Imports in tons
1930-31	197,000	232,000
1931-32	20,000	111,000
1932-33	2,000	33,000

It will be seen that both the exports and imports have declined considerably. The decline in the imports is due to the imposition of an import duty in March 1931.

The total estimated areas under improved wheats in India during the last three years were :—

Year	Acres
1930-31	5,025,889
1931-32	5,325,242
1932-33	5,316,173

The figures for 1931-32 and 1932-33 do not include the area under improved wheats in the North-West Frontier Province, which was estimated in recent years at 280,000 acres. It may therefore be taken that there are nearly 5½ million acres under improved wheats in India, or nearly one-sixth of the total area under wheat. Of this area, 2½ millions are in the Punjab, 2 millions in the United Provinces, half a million in Central Provinces and the remaining half a million distributed mainly between Bihar and Orissa and the North-West Frontier Province and Bombay.

Wheat has been the subject of extensive study at PUSA. The year 1931-32 was characterised by a particularly dry season during the cold weather and this was reflected in the freedom of the wheat crop from rust and the resulting excellent quality of the grain. The bushel-weights of the wheats grown at Pusa bear witness to the quality of the grain :—

Wheat	Weight per bushel in lb.		
	Average of past six years	1931-32	1932-33
Pusa 4	63·5	66·1	66·3
„ 12	61·35	65·0	64·3
„ 52	63·94	66·8	66·4
„ 111	..	66·2	67·1
„ 101	..	66·8	66·1
„ 114	..	66·7	64·2

In collaboration with the Sind Department of Agriculture, further milling and baking tests with Pusa wheats grown both at Pusa and in Sind, and with some Sind wheats grown in Sind, were carried out. These tests were made in the United States of America and indicate that Pusa 114 is the best wheat for Sind. This wheat had a protein content of 15·45 per cent., the next best in this respect being Pusa 111 which was very favourably reported on in the milling and baking tests performed in the United Kingdom in the previous year. Some of the Sind selections (*e.g.*, H. S. W. III) had a good protein content and gave under Sind conditions a high yield of grain. Punjab 8A proved low both in protein content and in yield of flour. Taking all the results together, it seems that the wheats which are most suitable for Sind are Pusa 114 and the Sind selections H. S. W. III and C. P. H. 47. Pusa 114 has during the past season proved very resistant to smut disease and also to rust and on account of this property obtained a premium of four annas per maund in Sind.

The wheat-breeding work with the hybrids between Federation and Pusa 4 and Federation and Pusa 52 has now reached the stage at which yield trials are being conducted with the more promising hybrids. One of the hybrids (No. 1054) has been found in the United States of America to be resistant to five physiological forms of *Puccinia triticina*. Two late-maturing hybrids having given very good results in the preliminary tests at the Karnal Sub-station, are now known as Pusa 120 and Pusa 165. Large-scale tests with these hybrids in comparison with the standard Pusa and Punjab types will be made simultaneously at Pusa, at Karnal, and at several farms in the Punjab and the United Provinces under various climatic and other conditions including canal-irrigated, well-irrigated, and rain-fed lands. Some crosses with Pusa 111 as a parent promise to give a bearded variety with the grain qualities of Pusa 111. Observations at Karnal have shown that Pusa 52, which is so well suited to Bihar conditions, is of very little use under irrigated conditions. A demand has however arisen in

the Kulu Valley of the Punjab for the seed of Pusa 80-5. Seed-supply from Pusa and Karnal amounted to 51,946 lb. in 1931-32 and 45,025 lb. in 1932-33; it consisted mostly of Pusa 52, Pusa 4, Pusa 12 and Pusa 111.

PUNJAB. On the average of the last three years the British Districts of the Punjab had 27·3 per cent. of the total area under wheat in India and produced 31·5 per cent. of the total crop. In 1930-31 the area under wheat was 9,287,000 acres, in 1931-32 it declined by 2 per cent. to 9,080,000 acres, and was further reduced in 1932-33 by 5 per cent. to 8,591,000 acres. This was due to the reduction of the area sown on irrigated lands on account of the prevailing low prices. Climatic conditions were also not favourable for the maturing of the crop and the outturn of 2,760,000 tons in 1931-32 was less than that of the previous year by 11 per cent. The season of 1932-33, on the other hand, was good for the development of the grain and, despite the reduction in area, a harvest of 2,813,000 tons was obtained. The area under improved varieties in 1931-32 was 2,771,880 acres as compared with 2,448,000 acres in the previous year. The next year however saw it reduced to 2,515,300 acres. Most of it is under Punjab 8A which accounted for 2,394,200 acres in 1932-33. While Punjab 8A still retains its position as the foremost general wheat, the results of recent research have enabled the Department to recommend to cultivators cross 518 as a high-yielding wheat for rich land and good water-supply, and Type 9D for poor land, poor irrigation and late sowing. These two have recently been placed on the seed-distribution list. Extensive field tests on the Government farms as well as on private land have shown that cross 518 is a much higher yielder than 8A and is an ideal wheat for rich, heavy soils where 8A, or other wheats, are likely to lodge. It possesses strong straw and consequently resistance to damage from hail. For the sixth year in succession 9D has given decidedly better results than 8A under *barani* conditions and on light and poor soils. Samples of several Punjab wheats were sent to the United States of America for milling and

baking tests. The results showed that the samples of 1931-32 were better than those of the previous year. A scheme for the establishment at Lyallpur of a laboratory milling and baking plant has been submitted to the Imperial Council of Agricultural Research and has received the approval of the Advisory Board. Ammonium sulphate and sodium nitrate applied to wheat at Lyallpur gave smaller increases in 1931-32 than in the previous year, apparently on account of the weather conditions being more favourable for soil nitrification. At Montgomery they gave increased yields but were not sufficiently remunerative at the present prices.

On the average of the last three years, the UNITED PROVINCES had 23 per cent. of the total wheat acreage in India and produced 30 per cent. of the total crop. The area of 7,748,000 acres put down to wheat in 1931-32 was 136,000 acres more than in 1930-31, but the area again fell to 7,667,000 acres in 1932-33. The last-mentioned year, however, recorded an yield of 2,713,000 tons, as compared with 2,610,000 tons in 1931-32 and 2,686,000 tons in 1930-31. The area under improved varieties rose from 1,800,000 acres in 1930-31 to 1,940,000 and 2,096,000 acres in the two years under review. Pusa 4, Pusa 12 and Cawnpore 13 still hold the field as the best varieties in common circulation and the area under each continues to increase. There is an increasing demand for Cawnpore 13 in certain areas on account of its high yield and quality. Punjab 8A is also rapidly becoming popular in some western districts. Several new varieties from Pusa and elsewhere have been accurately tested against Pusa 4 and Pusa 12 during the period under review. Some of them are promising. Certain of the Central Provinces varieties are being tested for Bundelkhand conditions.

The CENTRAL PROVINCES AND BERAR is the third important wheat-growing province in India, carrying on the average of the last 3 years 10·3 per cent. of the total area under wheat in India. In 1930-31 the area sown was 3,098,000 acres; it rose

to 3,518,000 acres in 1931-32 but again fell to 3,451,000 acres in 1932-33. The yield in the three years mentioned was 635,000, 673,000 and 655,000 tons, respectively. The area under improved wheats stood at 458,932 acres in 1932-33, as compared with 427,992 acres in 1931-32 and 377,372 acres in 1930-31. The Sharbati wheats A 113 and A 115, which formerly commanded a premium for export trade, have suffered in popularity. In years of drought they do not give statisfactory yields and specially in the trying conditions of 1933 they gave even lower yields than the old departmental selection A 090, though the Sharbatis have been known to out-yield this previously. They appear to have lost their rust-resistant property. This is probably not due to any inherent deterioration in the variety but to its having got mixed up with the local strains. The Department is therefore now making efforts to re-select these varieties and to maintain pure stocks. Work on the improvement of the wheat crop was continued by the Second Economic Botanist, the object being to produce a rust-resistant and high-yielding wheat for the main wheat tracts of the Northern Circle, and a rapidly-maturing, awned type of good cropping power for the Southern Circle. Two strains E. B. 8 and No. 31, which have reached the stage of trial on a field scale, are being tested in the Northern Circle. Out of the large number of crosses made between the Australian and local wheats, three have given hopeful results. A number of other crosses are under observation and further hybridization is in progress. An interesting confirmation of the statement that a heavy incidence of ' foot-rot ' in wheat is due to too high a temperature at sowing time was obtained in the season of 1931-32, when a prolonged rainy season was followed by a sudden drop in air temperature at the time of *rabi* sowings, was characterised by the comparative absence of foot-rot. The Department organized 6,218 seed-farms for wheat in 1931-32 and 5,697 in 1932-33, as against 5,539 in 1930-31. The total amount of seed distributed was 193,036 mds. in 1931-32 and 192,983 mds. in 1932-33, as compared to 152,938 mds. in 1930-31.

In the BOMBAY PRESIDENCY proper, wheat was sown on 1,691,276 acres in 1930-31; the area rose to 1,845,288 acres in 1931-32 but again shrank to 1,658,531 acres in 1932-33. The outturn in the last-mentioned year was 323,192 tons as compared with 281,260 tons in 1930-31 and 325,598 tons in 1931-32. Estimates of the total area under improved varieties are not available but the departmental farms sold seed sufficient to sow 30,551 acres in 1931-32 and 20,526 acres in 1932-33, as compared with 11,259 acres in 1930-31. The Nasik-Khandesh area is the most important wheat-growing tract in the Presidency and wheat-breeding is conducted at Khandewadi in Nasik District. A strain No. 103, which has been selected out of the local Bansi variety, has given the best yield and is being multiplied for distribution. In East Khandesh two strains, Nos. 162 and 168, have become popular and in West Khandesh strain No. 224 has proved a high yielder. A hybrid from Bansi and Kala-Khapli is under study and some of the strains possess a large grain with an attractive lustre. Green-manuring with sann-hemp has been found to be profitable for wheat in the Deccan Canal area.

In SIND the Lloyd Barrage Canal system commenced supplies with the *kharif* of 1932 and, as a result of the assured water-supply thus made available, both the area and outturn of wheat in 1932-33 were fifty per cent. greater than in the preceding year. The year 1932-33 saw 969,271 acres under wheat from which 279,300 tons were harvested, as against 469,117 acres and 118,147 tons in 1931-32. The area under improved wheats similarly rose from 86,052 acres in 1930-31 to 103,247 acres in 1931-32 and 173,937 acres in 1932-33. A series of major wheat varietal trials carried out every year at various centres has established that, for irrigated conditions, the Phandani selection C. Ph. 47 is best suited for Middle and North Sind, Punjab 8A for East Sind, and the improved Pusa wheats 12 and 114 for general cultivation all over Sind. For *bosi* conditions in North Sind the improved Thoree wheat AT 38 stands first in point of yield with C. Ph. 47 a close second.

A new improved selection H. S. W. 111 appears suitable for Lower Sind. Samples of improved varieties were sent to the United States, Holland and Scotland for milling and baking tests, and the reports are unanimous that Pusa 114 is superior to all other varieties in this respect. These improved varieties are being multiplied on a large scale. In accordance with a seed-extension scheme, the amount of seed made available for further multiplication in 1932-33 was about 2,800 mds. and 1,190 mds. in 1931-32. Work on the improvement of wheat in Sind is centred mainly at Sakrand, and includes trials of imported varieties and the improvement of the indigenous strains by selection and hybridization. Among the imported varieties those which are promising are a new Punjab variety C. 158 and four Australian wheats. Among selections from Sind wheats H. S. W. 111 and 285 G. S. W. appear hopeful. The hybrid wheats C. Ph. 47 × Pusa 12 and C. Ph. 47 × Pusa 114 are also under trial.

In BIHAR AND ORISSA the reported area and yield of wheat have hardly shown any variation during the last three years; in 1932-33 a crop of 492,000 tons was harvested from 1,235,000 acres. The area under improved varieties increased from 23,206 acres in 1930-31 to 37,907 acres in 1932-33. Pusa 52 continues to be popular all over the province and is yet unbeaten whether grown under irrigated or unirrigated conditions. At the Sabour Experiment Station, Pusa 52 was compared with the new Pusa selections and with Pusa 4. The results of 1931-32 indicated that Pusa 114 was better than Pusa 52, but in 1932-33 Pusa 4 appeared to be better both under irrigation and without irrigation. Among the manures tried, a combination of 20 lbs. of nitrogen and 25 lbs. of $P_2 0_5$ gave the best results under North Bihar conditions.

The area of 1,012,000 acres sown with wheat in the NORTH-WEST FRONTIER PROVINCE in 1932-33 was practically the same as in the previous year but it represented an increase of nearly 14 per cent. over that of 1930-31. There was not a corresponding increase in outturn which was estimated at 237,000 tons

in 1932-33 as against 216,000 tons in 1930-31. The area under improved varieties was estimated in 1930-31 as 280,000 acres, but later figures are not available. The most important variety grown is Pusa 4 which does well on double-cropped, irrigated areas, and the next in importance is Federation which suits single-cropped areas. At the Tarnab Agricultural Station several new varieties from the Punjab are under trial against Pusa 4. The new Punjab varieties C. 518 and C. 409 which are bearded and early-maturing are expected to find favour with the zamindars. About 125 mds. and 200 mds. of pure seed, mostly Pusa 4, were sold to the zamindars during the two years under review.

3. Cotton.

The two years under review witnessed continuance of the decline in the area sown with cotton in India. From the record figure of 28,403,000 acres in 1925-26 the area fell to 23,616,000 acres in 1930-31, and 23,722,000 acres in 1931-32, and further dropped to 22,558,000 acres in 1932-33, with a recovery to 23,739,000 acres for 1933 sowings for the 1933-34 crop. The season, too, was unfavourable in 1931-32, the average yield per acre being as low as 68 lbs. and the total estimated production was only 4,025,000 bales of 400 lbs. The 1932-33 crop fared better, the total estimated production being 4,516,000 bales with an average yield of 80 lbs. per acre. Compared with the estimated production of $5\frac{1}{4}$ million bales in each of the two previous seasons, and the $6\frac{1}{4}$ million bales of 1925-26, the reduction in the estimated yield of Indian cotton during the two years under review was therefore very considerable. The total crop accounted for by press returns and loose cotton received at mills was 3·5 million bales in 1931-32, and 4·9 million bales in 1932-33, as against 5·4 and 5·1 million bales, respectively, in 1929-30 and 1930-31. The failure of the Oomras crop in 1931-32 and the consequent scarcity of Indian cotton sent up prices relative to those of American cotton. Indeed at one time during the season, fine Oomra was quoted higher than Middling American. As a result, exports fell off from 3,729,000

bales in 1930-31 to 1,582,000 bales in 1931-32. In the following year, however, exports recovered to 2,741,000 bales consequent upon the prices of Indian cotton receding to a normal parity with American cotton prices. The rise in the relative prices of Indian cotton in 1931-32 also resulted in a larger import of American cotton into India, *viz.*, 245,000 bales as against the 129,000 bales of the previous season. In 1932-33, however, prices were not so attractive and imports fell to 65,000 bales. The same factors were responsible for the reduction in the world's total consumption of Indian cotton which, according to the figures compiled by the International Federation, was 4,514,000 bales during the year ending 31st January 1934, as against 4,035,000 bales during the corresponding previous year and 5,662,000 bales and 6,115,000 bales, respectively, during the year ending 31st January 1932 and the corresponding previous year.

The INDIAN CENTRAL COTTON COMMITTEE, constituted in 1921 as an advisory body and later incorporated under the Indian Cotton Cess Act of 1923 and provided with funds of its own, continued, during the period under review, to make steady progress in its work for the improvement and development of cotton-growing, marketing, and manufacture of cotton in India. During the period under review a pamphlet entitled "Cotton Improvement in India" setting forth the various problems which cotton improvement in India involves, the efforts made by the Committee to solve some of these problems, and the results hitherto achieved, was widely circulated and criticisms and suggestions invited from all representative bodies. The criticisms received showed that the Committee's past work and research policy had the general approval of the public and that its activities were on sound lines and that substantial progress had been made. In order to make its work more widely known to the public and to the general body of cotton-growers in particular, the Committee has now embarked on a policy of publicity and propaganda, and a special officer was appointed for this purpose in June 1932.

The practice of importing inferior cotton into areas growing superior varieties and then passing on the imported inferior stuff, either mixed or unmixed with the local cotton, to unwary buyers as genuine local superior cotton, was once so prevalent in the staple cotton tracts of India that by slow degrees the premia obtained for the cotton of certain tracts disappeared. The *Cotton Transport Act* passed by the Government of India in 1923 is designed to check this evil, which is a grave menace to the growing of superior cottons in India. This Act enables a local Government to notify any cotton-growing area as a protected area and thus to prevent the importation of inferior cotton or seed into areas growing superior varieties. During the period under review there were seven such protected areas in the Bombay Presidency, two in the Madras Presidency, and one in the Central Provinces. The Indian States of Baroda, Rajpipla, Chhota Udepur, Sangli, Hyderabad, and Indore have likewise introduced legislation on similar lines to protect tracts growing superior cottons within their territories.

The main object of the Cotton Transport Act is to create and maintain islands of superior types of cotton in tracts where, though soil and climatic conditions are favourable for the growth of the better cottons, their production is hampered by the short-sighted policy of growers and the unscrupulousness of middlemen. The question of the types of cotton to be grown in such islands is therefore one of paramount importance. The Committee has given considerable attention to the comparative merits of Surat 1-A and 1027 A. L. F. for the three zones protected in the Surat tract, and a large mass of data relating to the comparative yield, quality, spinning performance and price of these cottons has been collected during the period under review. It has since been decided to grow only 1027 A. L. F. in the protected area in the Surat tract and to eliminate Surat 1-A.

It has not yet been possible to advise the farmers as to a single type of cotton most suitable for the Nerbudda-Mahi zone,

but the problem is being tackled in the Broach Cotton Breeding Scheme financed by the Committee, and meanwhile the application of the Cotton Transport Act has checked the deterioration. In the Kumpta-Dharwar zone in the south of the Bombay Presidency, Jayawant cotton is rapidly replacing the local ordinary Kumpta cotton. Similarly, the selected strain Gadag-1 is spreading rapidly and replacing ordinary Dharwar American Upland.

Jayawant and Gadag-1 are also being pushed in the Raichur protected area of the Hyderabad State. Efforts are also being made under a scheme financed by the Committee to evolve a still better type of cotton for the Hyderabad Gaorani protected area than the present Bani mixture grown therein.

In the Madras Presidency the full benefits of the Act have not been realised due to the absence of restrictions on the movement of cotton by road and river. Cocanadas cotton and cotton from the Hyderabad State are imported into the Kurnool and Bellary districts of the Northerns and Westerns protected area, and Mysore and Malabar cottons into Tirupur in the Southerns protected area. The recent action of the Madras Government in excluding the *talukas* of Markapur and Cumbum in the Kurnool district from the Northerns and Westerns area should, however, go a long way in checking the import of Cocanadas cotton into the protected area.

During the period under review the Holkar Durbar, at the instance of the local mills, removed all restrictions on the import of any but *Desi* Mewadi cotton into the State. As the Committee was not convinced of the wisdom of this step, the matter is now under consideration.

The *Cotton Ginning and Pressing Factories Act* was passed in 1925 to ensure the maintenance in ginning and pressing factories of records of ownership of the cotton ginned and pressed in them, the marking of bales, and the submission of statistical returns. The marking of bales is the most important feature of the Act, as under its operation, the origin of every

bale is traceable by the marks thereon, thus enabling the trade to protect itself against fraudulent practices by refusing to accept bales pressed in factories notorious for such practices. It is also highly satisfactory to note that the labours of the Committee in enlisting the co-operation of Indian States, and the introduction of similar legislation in their territories, have been fruitful. There is now not a single Indian State possessing a pressing factory which has not introduced this measure.

During the period under review the Act worked smoothly and, as usual, all cases of infringements reported to the Committee were brought to the notice of the provincial authorities for necessary action. In cases of watered and falsely packed cottons, certified copies of the entries in press registers were called for and furnished to the complainants.

The provisions of the Cotton Ginning and Pressing Factories Act do not however make the various malpractices punishable by law. The hope that with the compulsory marking of bales such practices could be stopped by the trade itself not having materialised, the Indian Central Cotton Committee, after ascertaining the opinion of the various cotton trade associations in India on the subject, has recommended that the Act be suitably amended so as to provide for the licensing of gins and presses in those provinces where this is necessary.

Cotton Marketing.—During the period under review further progress was made in the work of improvement of marketing conditions. The establishment of a cotton market at Amalner under the Bombay Cotton Markets Act, 1927, was sanctioned by the Government of Bombay. The Madras Commercial Crops Markets Act, which provides for the better regulation of buying and selling of cotton, groundnut and tobacco and the establishment of markets for them, was before the Committee during much of the period under review and came into force in July 1933. In the Central Provinces Legislative Council, a member of the Indian Central Cotton Committee introduced a non-official bill to provide for the establishment and better regulation of cotton markets. This bill became law

in August 1932. Under the Hyderabad Agricultural Markets Act five regulated markets, *viz.*, Jalna, Umri, Latur, Sailu and Nanded functioned during the period under report. The revised rules under the Indore City Cotton Market Act, providing for a larger representation of the growers on the Market Committee came into force in March, 1932. Three more Indian States have also shown interest in this matter : the Dhar State introduced similar measures in 1929, Sangli has now a bill before its Legislative Assembly, and Baroda has the matter under consideration.

A notable development during the period under review was the establishment of the Karachi Cotton Association, Ltd., as a duly registered association. The Association assumed control of the whole cotton trade of Karachi from the 1st August 1933. On the same day the Karachi Joint Cotton Committee, which had helped in the establishment since 1927 of a single agency for the control of the cotton market at Karachi, ceased to exist.

Further progress was made by the Indian Central Cotton Committee with the idea of universal standards for Indian cottons. Having obtained and considered the opinions of the various trade associations in India on this subject, the Committee decided first to concentrate attention on introducing common standards in India itself. As Karachi and Bombay are the only two markets in India which prepare standards, it has further been decided to have common standards prepared for these two markets for such cottons as are dealt with in both places.

Means to prevent the Introduction of Foreign Cotton Pests: —The American Cotton Boll-weevil (*Anthonomus grandis*) and the Red (Sudan) Boll-worm (*Diparopsis Castanea*) are two pests which have caused much ravage in their respective native countries, and which might easily be introduced into India, through unregulated imports of American cotton and foreign cotton seed, respectively. Import of both has therefore been restricted to the Port of Bombay, where proper

fumigation facilities are provided. These restrictions worked smoothly during the period under review. During the years ending 31st August 1932 and 1933, respectively, 244,695 and 65,446 bales of American cotton, and 6 and 22 parcels of cotton seed were received and fumigated, the former with hydrocyanic acid gas and the latter with carbon bisulphide.

Cotton Statistics.—The improvement of cotton statistics is a matter to which the Committee has devoted considerable time and attention. As a result, the statistics relating to this crop are already more complete than those for any other crop in India, but a few gaps still remain to be filled. The quantity of cotton that is used in the villages for such domestic purposes as hand-spinning, making quilts, mattresses, etc., is one such gap and the carry-over of cotton from one season to the next is another. During the period under review the Committee sanctioned the funds required to enable investigations to be carried out in Madras, Bombay, Baroda, Sind, the Central Provinces, the United Provinces, the Punjab and Bengal to ascertain the quantity of cotton that is used in the villages. The co-operation of the local trade associations at important cotton centres in India has also been enlisted in making an annual census of the cotton stocks held by the trade at these places, on the last day of the season, *viz.*, the 31st August. Statistics relating to mill stocks are collected by the Committee direct from the mills. The Committee now compiles and publishes statistics relating to the quantities of various kinds or growths of Indian cotton exported from India and received in the mills in India.

An important development in the activities of the Committee during the period under review was the appointment of a Cotton Forecast Improvement Sub-committee, which includes the officers responsible for the compilation of cotton forecasts in the major cotton-growing provinces and states and the Director-General of Commercial Intelligence and Statistics. The main function of this Sub-committee will be to make recommendations for improving the accuracy of Government cotton forecasts.

Cotton Research.—In the foregoing paragraphs the activities of the Committee in regard to improvements in the marketing of Indian cotton have been described. This is only one aspect of the problem of putting more money into the pockets of the cultivator of cotton, whose welfare is the chief concern of the Committee. The second and more important aspect of providing the cultivator with the type of cotton most profitable to him under the conditions in which he has to grow it, has always been in the forefront of the Committee's programme. Liberal grants have been made by the Committee to the Provincial and State Agricultural Departments to enable them to investigate the botanical, physiological, entomological, mycological and agronomic problems confronting them in their respective areas. The Committee also maintains a Technological Research Laboratory and is the chief supporter of the Institute of Plant Industry, Indore.

Technological Laboratory.—This Laboratory, established at Matunga, Bombay, in 1924, supplies a long-felt want of the cotton-breeders of India. Before its establishment cotton-breeders had to wait, and probably waste, six to seven years before they could raise sufficient quantities of new strains of cotton evolved by them to enable spinning tests to be carried out on their samples in an ordinary mill. The Technological Laboratory of the Indian Central Cotton Committee is so designed that it can carry out spinning tests on very small quantities of lint, *viz.*, 12 lbs. or less, such as the breeders can produce in the third or fourth generation of the strains under observation. Thus, the Technological Laboratory saves cotton-breeders a good deal of time and energy and expedites the solution of the problems under investigation. That the facilities offered by the Technological Laboratory are being increasingly appreciated by research workers of the Agricultural Departments in India is borne out by the steady increase from year to year in the number of samples tested at the Laboratory. Such samples include both new strains of cotton under varietal trials and samples of established cotton grown under various

conditions in order to find the effect on lint quality. During the period under review 489 samples were tested as against 398 samples during the preceding two years, and 103 samples during the first two years since the Laboratory was established. In addition, tests on each season's samples of the standard Indian cottons were carried out, as usual, during both the years covered by this review, and the results published. A third series of tests undertaken by the Laboratory is meant for the benefit of the trade and industry. In this series commercial samples of fair average cotton of the most important growths, selected by the East Indian Cotton Association, and samples of the first arrivals of these at mills, supplied by arrangement with the Bombay and Ahmedabad Millowners' Associations, are tested and the results published in " Technological Circulars " with the results of previous tests. A notable achievement of the Laboratory during the period under review was the perfecting of a method of determination of the mean fibre-length and fibre-weight per inch of the cotton fibre by a single operation and the designing of an apparatus which has since been patented. In view of the intimate relation that exists between the above-mentioned fibre-properties of cotton and its spinning performance, and the ease and facility with which both these properties can be correctly determined, the new apparatus should prove of great value. The study of the variation with atmospheric humidity, in the moisture content of bales stored in the Cotton Exchange Building at Sewree, referred to in the last Review, was completed during the period under report and a detailed account published (Technological Bulletin, Series A, No. 23). The determination of the moisture content in specially-pressed bales and in trade bales was completed during the period under review. The spinning tests on Indian staple cottons, *viz.*, Punjab-American 289-F., 1027-A. L. F., Cambodia and Nandyal-14, combed to different degrees were also completed and the results have since been published in the form of a bulletin.

The Indore Institute of Plant Industry was started in 1924 mainly as a central research institute for cotton, in considera-

tion of which the Indian Central Cotton Committee has now spent over eleven lakhs of rupees on the Institute. It is gratifying to note that the Institute is becoming more popular among the States in Central India and Rajputana, and that no less than twenty of them have now joined as contributing members. Impressed by the impoverished condition of the soil of the Malwa Plateau, Mr. Howard,* the first Director of the Institute, concentrated his attention on the improvements to be effected in the agronomy of cotton. Besides suitable and efficient methods of grading fields and effecting surface drainage, an easy and practical method of eradicating the perennial weed *kans* (*Saccharum spontaneum*) which does much harm to crops, was introduced. The problem of obtaining suitable organic manure was also satisfactorily solved by placing at the disposal of the cultivator a practical and economical method of converting farm refuse into valuable organic manure. This process has since been much simplified with consequent economy in water and labour. During the period under report, the programme of work and the results hitherto achieved by the Institute were reviewed by the Committee, and it was decided that the Institute should devote hereafter greater attention to research on the cotton plant than hitherto. As regards the selection of an improved strain of Malvi cotton for the Malwa Plateau, it looks as if in a year or two the Institute would definitely be in a position to distribute an improved type of cotton. Other work on the botany, physiology and genetics of cotton is in progress. Many of the problems connected with the improvement in the growing of cotton in India are of a kind that cannot be solved at one central Institute. Accordingly the Committee has systematically encouraged local investigations in the provinces and states into their main problems, and to assist those the results of which would not only be applicable locally. It is the recognised policy of the Committee to avoid financing research which is of purely academic interest, and to concentrate attention on those investigations which have

* Now Sir Albert Howard.

a definite economic end in view. During the period under review thirty-two such research schemes were being financed by the Committee. The Committee has also helped the agricultural departments with funds to enable them to bring into general cultivation the seed of improved varieties of cotton. Fifteen such schemes operated during the period under report.

In the BOMBAY PRESIDENCY two research schemes, *viz.*, the Surat Physiological Scheme and the Dharwar Wilt Scheme, which have been in operation since 1924, were closed down during the period under review. The nature of the work done under the first of these schemes and the results obtained therefrom have been described at some length in the last Review. Valuable results have also been obtained from the investigations on cotton wilt carried on at Dharwar. The causal organism has been identified, the range of soil temperature at which the disease is at its worst has been determined, and it has also been shown that the disease can be carried in seed. Monographs embodying the research work done and the results obtained in these schemes have also been written, and are being published by the Imperial Council of Agricultural Research. Reference was made in the last Review to the decision of the Agricultural Department to give effect to the results of the Surat Entomological Research Scheme by a large-scale effort to eradicate the spotted boll-worms in an area of about 480 square miles in Gujarat. Intensive propaganda was carried out, demonstrating the use of plant-pullers in removing cotton-stalks and other host plants and stubbles from the field immediately after harvest. This propaganda campaign, which lasted from April 1931 to January 1932, was followed up at once, and also in the next season by the regular cleaning-up of the selected area. Though the clean-up work in 1932 was not quite satisfactory, it was quite a success in 1933.

Cotton-breeding work is in progress in the Bombay Presidency proper at five centres, *viz.*, Surat, Broach, Viramgam, Jalgaon and Dharwar; the work at Broach and Jalgaon is

assisted by the Indian Central Cotton Committee. Both schemes commenced work in April 1932. They aim at securing wilt-resistant cottons of superior quality for their respective areas, *viz.*, the Khandesh tract and the Nerbudda-Mahi tract. It is reported from Surat that a cross between 1027 A. L. F. and 1-A Long Boll possesses the desirable characters of both the parents.

During the period under review five Seed Distribution and Extension Schemes were under operation in the Bombay Presidency. The Co-operative Cotton Sale Societies at Hubli and Gadag collected and distributed pure seed of Jayawant and Gadag-1 cottons in their respective areas under departmental supervision. At Athani, too, Jayawant is likewise extended. In the Surat-Broach tract 1027 A. L. F., and in Khandesh Banilla, are extended under the direct control and supervision of the Agricultural Department.

In SIND, botanical research at Sakrand directed towards the production of the most suitable varieties of long, medium and short-staple cottons for Barrage conditions, and the study of their comparative economic value to the cultivator is financed from Departmental funds; for the physiological investigations including the optimum time of sowing and the water-requirements of the cotton plant, the funds are provided by the Indian Central Cotton Committee. Further progress with all these investigations was made during the period under review. It has been definitely established that 27 W. N. (*Desi*) surpasses in gross yield of *kapas* per acre every other type tried. Of the Punjab-American types, 285-F and 289-F appear to be more profitable than 4-F. The yields of long-staple exotics were not encouraging, and their extension, unless hardier strains can be evolved, depends on the premium which the cotton can fetch in the market. It has been ascertained that the optimum period for sowing is from March 15th to May 15th, and that the cotton plant requires a total (delta) of 36·9 in. of water. The best method of distribution of this water, as well as other problems, are now under investigation.

A special organisation for the extension of improved types into general cultivation is also being financed by the Committee.

Cotton research work in the CENTRAL PROVINCES continued to receive substantial support from the Indian Central Cotton Committee during the period under review. Reference has been made in previous reviews to the improved type Verum 262, which is one of the results of research in the Provinces. The estimated area under this cotton in 1933 was 89,000 acres. With the aid of a grant from the Indian Central Cotton Committee a special marketing organisation was maintained which handled 3,971 bales and secured an average premium of Rs. 36-13-0 over Broach. The Agricultural Department is not satisfied that Verum 262 is the ideal cotton for the province. Further selection work has therefore been in progress, and a few very promising types have been selected for multiplication and extension. One of these, Late Verum, spins up to 31's standard warp counts and, as the name indicates, is a late variety, particularly suitable for tracts where rains in September adversely affect the crop. Verum 434 is another strain which, while possessing the other good qualities of Verum 262, is of longer staple and more hardy type for tracts of varying conditions of soil and climate. Verum 438 is still another type which is specially suited for the lighter soils. Two Bani strains E. B. 31 and 306 are also maintained : these spin 40-50's standard warp counts, but they suffer, as all *indicum* strains do, from the serious defect of low ginning percentage. An improved type of Chanda Jari capable of spinning 30's counts has also been developed.

Root studies show that the hardiness of Rose cotton is due to a better root system. Studies of the seedling blight of cotton and anthracnose disease were also in progress.

Under the scheme financed by the Indian Central Cotton Committee for the extension of Verum 262, the roguing, collection, ginning and marketing of this cotton under Departmental supervision continued during the two years under report.

Cotton research in the PUNJAB is extensively financed by the Indian Central Cotton Committee and investigations, on the success of which may depend the future of American cotton in the Punjab, have been under way since 1925. The baffling problem in the province is the periodical partial failures of Punjab-American cotton. Research is therefore directed towards evolving a type of cotton which will successfully withstand the conditions of unfavourable years and to an analysis of the factors responsible for these failures. Reference has been made in the previous Review to the selection of early strains of Punjab-American which are hardy, resistant to jassid-attack and less liable to periodical ' failure '. Further trials with these strains during the period under review have confirmed the hopes entertained of it and arrangements were made for one strain (N. T. 43) to be tried on a very large scale during 1934. The investigations carried out by the various specialist officers of the Punjab Agricultural Department on different aspects of the periodic failure of cotton in the Punjab having shown that an intensive programme of physiological research under a whole-time officer was absolutely necessary for the elucidation of the problem, a comprehensive scheme was prepared and has since been approved by the Indian Central Cotton Committee and a grant made.

In the last review reference was made to the main conclusions arrived at from the study of the pink boll-worm in the Punjab since 1926. It was decided in 1933 that certain further observations on the incidence of the pest, temperature and humidity were required and these were arranged for as part of the new scheme sanctioned for the study of the spotted boll-worm. Considerable progress was made in the study of the cotton white fly and of control measures. Two sprayings in July and August with rosin compound or fish-oil soap appear to be effective and large-scale spraying trials were arranged for during 1933-34 to determine the economics of the method of control.

During the period under report investigations have also been started with a view to determine the organism causing root-rot disease, and the control measures for it.

In the MADRAS PRESIDENCY selection and hybridisation work is in progress at Coimbatore, Guntur, Nandyal, Hagari and Koilpatti to produce better strains of cotton suited to the tracts served by them. Several series of experiments are under way. In one of these in which new Cambodia strains were tested for yield, it is gratifying to note that for the first time Co. 2 was beaten by three strains. A strain called Karunganni 546 has again shown its superiority over C. 7 in yield on black soils when tried at Koilpatti in ryots' fields. At Guntur promising results were obtained in single-plant selections made from Cocanada and Cambodia. At Nandyal a few strains, which showed superiority over N-14 in yield in the first year, were found to be only equal to N-14 in the second year. At Hagari some of the new selections, though found superior to H. 1 in yield, were poor in ginning percentage.

Three research schemes, *viz.*, the Herbaceum Scheme, the Pempheres and Physiological Scheme, and the Fodder *Cholam* Scheme are financed by the Indian Central Cotton Committee. In the Herbaceum Scheme, which has been in existence since 1923, efforts are being made to evolve a type of cotton as good as Karunganni in lint qualities and as hardy as Uppam. The method of single-plant selection from Uppam having failed to yield the desired result, attention is now concentrated on hybridisation and the use of X-rays. It is too early to judge the results. In the Fodder *Cholam* Scheme the harmful effects of fodder *cholam* as compared with *cumbu*, as a rotation crop on the succeeding cotton crop, are being investigated. The results so far obtained show that if fodder *cholam* is not allowed to run to seed, and is cut at the shot-blade stage, the yield of the succeeding cotton crop is not reduced, but the quality and quantity of the fodder is reduced thereby. The growing of a mixture of a late variety of *cholam*, and a bulky leguminous fodder crop appears to offer a solution to this difficulty.

The extension of Cambodia cotton growing in the Coimbatore district under a scheme financed by the Indian Central Cotton Committee is in progress.

In the UNITED PROVINCES the Department of Agriculture continued its policy of distributing the improved types C-402 in the Sarda Canal area, C-520 in the western cotton districts and A. 19 elsewhere.

The main scheme of experimental work on the control of the Pink Boll-Worm in the United Provinces was completed in 1931. Since then demonstration work has been carried out on a large scale for a further period of three years. Five years' work had already shown most conclusively that these boll-worms could be effectively controlled by seed treatment and that if these methods were systematically applied throughout the main cotton tract of the United Provinces, the centre of which is Aligarh, an increase of 25 to 40 per cent. in the yield per acre of marketable cotton could be secured. In 1932-33 control work was carried out on about 51,750 acres of cotton and amply confirmed previous year's results. All cultivators' seed for sowing was sun-heated during the hot weather and supplies of heat-treated seed for cattle food were arranged. It now only remains to equip all ginneries in a given area with machines for the heat-treatment of seed and to regulate the movement of untreated seed for a certain portion of the year. A scheme with this object has been prepared, a promise of financial assistance for a period of five years secured from the Indian Central Cotton Committee, and the scheme approved by the provincial committee. The scheme is now under the consideration of the Local Government.

In BURMA botanical research on cotton is carried on at the Mahlaing and Allanmyo Agricultural Stations. Demonstration work to improve the individual holdings of cultivators was in progress in the Myingyan Circle, during the period under review, with the help of a grant made for the purpose by the Indian Central Cotton Committee. It is gratifying to note that the cultivators who adopted better methods of cultivation

obtained higher yields, and that more and more cultivators are taking to the new methods.

In the HYDERABAD STATE a Botanical Research Scheme financed by the Indian Central Cotton Committee started in 1929. Work was continued on the selection of a Gaorani strain, with satisfactory lint qualities, yield and ginning percentage and which would be at least as paying as *Roseum* to the cultivators of the Gaorani protected area. A number of pure strains of Gaorani were tested for yield in 1932-33. A detailed survey of the cottons grown in the State has also been in progress during the period under review.

A seed distribution scheme for the supply of pure seed of Jayawant and Gadag No. 1 in the Raichur district was also in progress, whilst pure seed of Gaorani cotton and Banilla was distributed in the Gaorani area and the Aurangabad district, respectively.

In BARODA, the Agricultural Department co-operated with the Bombay Agricultural Department in determining by comparative yield tests, the relative merits of 1027 A. L. F. and 1-A for the Surat zone, in which is included the Navsari district of the Baroda State. As in the Punjab, root-rot is a disease which takes a heavy toll of cotton in the sandy alluvial soils of Gujarat. The study of this disease and the breeding of resistant types of cotton have therefore been taken up under a new scheme which commenced in February 1932. The Baroda Agricultural Department continued its policy of pushing 1027 A. L. F. in the Navsari district, Broach 9 in the Baroda district, Wagad 8 in the Mehsana district, and Dhulia No. 1 in the Amreli district, this being in full accord with the policy now followed in British Gujarat.

On the Babbur Farm in MYSORE STATE investigations were continued on the usual lines. Arrangements were made for the distribution of pure seed of Selection 69, for which there appears to be an increasing demand.

The small scheme financed by the Indian Central Cotton Committee in BIKANER STATE with a view to obtaining types

of Indian and American cottons suitable for the Gang Canal tract was continued. It appears that ' Mollisoni ' an improved short-staple type, largely grown in the adjoining parts of the Punjab, has the best chance of success.

Co-operative Cotton Sale Societies.—With a few exceptions, the working of the Co-operative Cotton Sale Societies in the Bombay Presidency including Sind was on the whole satisfactory during the period under review. There were in all 23 and 26 societies, respectively, during the years 1931-32 and 1932-33 in the Presidency, and they sold about 325,000 maunds of cotton and realised about 26½ lakhs of rupees during each of the years under report. It is noteworthy that the Gadag Society was able, as the result of successful working, to give to its members a bonus equivalent to the commission charged for selling their cotton. The societies in Gujarat are increasing in popularity, as they can secure better prices, and lower ginning and pressing charges. Reference was made in the last Review to the appointment in the Madras Presidency from March 1931 of a Deputy Director of Agriculture on Special Duty under the Registrar of Co-operative Societies for organising, developing, and giving technical assistance to Cotton Sale Societies in the principal cotton areas of the Presidency. Unfortunately the Madras Government abolished this post from 1st April 1932 as a measure of a retrenchment. In Madras there are no Co-operative Sale Societies for Cotton alone, but the Co-operative Loan and Sale Societies in the principal cotton areas do business largely in cotton. In the two years under review the five principal societies in the Presidency did business amounting to seven and five lakhs rupees, respectively. In the Tiruppur area the Business Manager provided by the Indian Central Cotton Committee continued to help the societies in grading and marketing their cotton. During the second half of the period under report, the Tiruppur Society began to work a large seed scheme financed by the Indian Central Cotton Committee for extending Cambodia (Co. 2) cotton. In the Central Provinces there are no Co-operative Cotton Sale Societies of

growers. In the Punjab also, as in the Central Provinces, there are no co-operative societies of growers purely for the sale of cotton. The societies in the Punjab deal in all sorts of produce for members and are known as Co-operative Commission shops. The Society at Okara, *viz.*, the Zamindara Sale Society sold cotton worth Rs. 4,04,000 in 1931-32, and Rs. 3,85,000 in 1932-33. Seventeen other Commission shops worked in 1931-32 and sold cotton worth Rs. 5,98,000 as against 16 Commission shops in 1932-33 which sold cotton worth Rs. 5,07,000.

In the Baroda State 17 and 16 Cotton Sale Societies, respectively, worked in the years 1931-32 and 1932-33 and sold lint and seed worth 8 lakhs rupees and 13 lakhs rupees, respectively. The two Cotton Sale Societies in Mysore State did not function, but the Credit Society at Maradihalli distributed seed of Sl.69 to its members, pooled the produce and ginned and sold it, thereby getting a higher price besides saving commission charges.

4. Sugarcane.

Weather conditions during the two years under review were reported to be generally favourable for the sugarcane crop. The area under this crop in the various provinces of India and the Indian States according to the Final General Memorandum issued by the Department of Commercial Intelligence and Statistics, was estimated to be 3,435,000 acres in 1932-33 as against 3,076,000 acres and 2,902,000 acres during 1931-32 and 1930-31 respectively, while the production of raw sugar (*gur*) was estimated at 4,859,000 tons in 1932-33 as against 4,116,000 tons and 3,359,000 tons during 1931-32 and 1930-31, respectively.

The impetus given to the Indian sugar industry by the grant of protection in 1932 began to bear fruit during the season 1932-33. Fifty-seven factories making sugar direct from cane worked during 1932-33, as against 32 and 29 during 1931-32 and 1930-31, respectively. Out of the 57 factories which worked direct with cane in 1932-33, thirty-three are situated in the

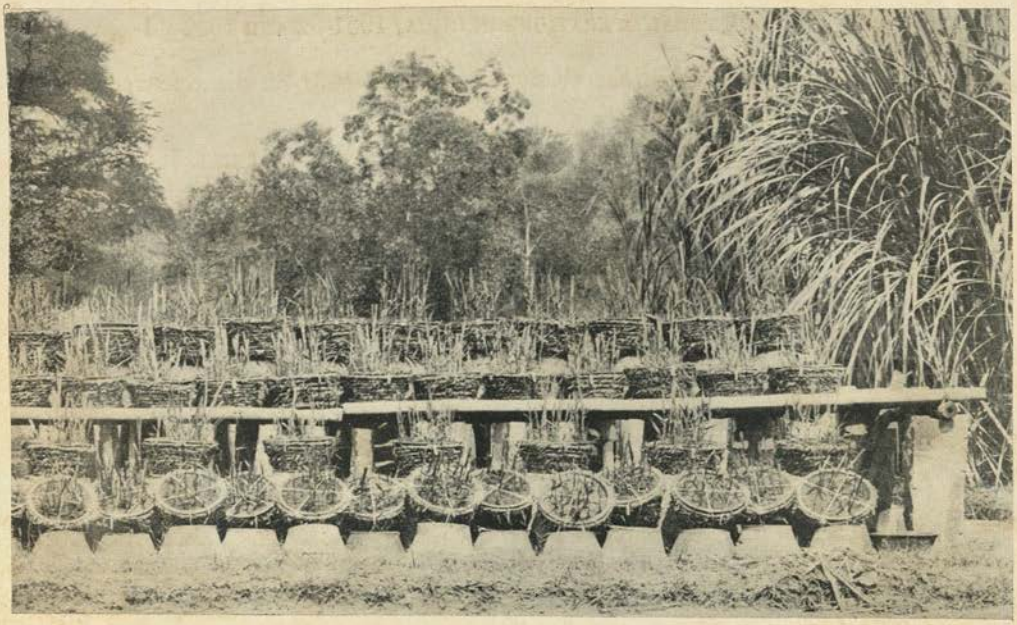
United Provinces, nineteen in Bihar and Orissa, one in the Punjab, two in Madras, one in Bombay and one in Burma. The production of refined sugar in India by factories working direct with cane amounted to 290,177 tons during 1932-33, compared with 158,581 tons in 1931-32 and 119,859 tons during 1930-31. It is satisfactory to note that the average recovery of sugar on cane in factories which worked for the first time during 1932-33 was as high as 8·55 per cent. The highest recovery for old and new factories combined during the season was 11·1 per cent. as against 11·3 per cent. during 1931-32. For India as a whole the recovery has dropped from 8·89 per cent. in 1931-32 to 8·66 per cent., as compared with 9·09 per cent. in 1930-31. The decline appears to be due partly to the larger quantity of cane crushed, necessitating a prolongation of the season.

In 1933 there were forty-five concerns in India equipped for refining *gur* or raw sugar compared with thirty-seven in the previous year. Of these, thirty-two also manufactured sugar direct from cane and thirteen worked with raw sugar alone. Of the former, sixteen refined *gur* during the year 1933, and of the latter, eleven are known to have worked during the year. There were thus twenty-seven factories refining *gur* in 1933 as against seventeen and ten factories during 1932 and 1931, respectively. Of these, sixteen are situated in the United Provinces, three in Bihar, four in Madras and four in the Punjab. The production of sugar refined from *gur* or raw sugar in India was 80,106 tons in 1933 as against 69,539 tons during the previous year. The total production of sugar in India by modern factories was 370,283 tons in 1932-33 as against 228,120 tons during the previous season. In 1930-31 imports of foreign sugar amounted to 901,000 tons. In 1931-32 these fell to 556,000 tons and in 1932-33 to 401,000 tons.

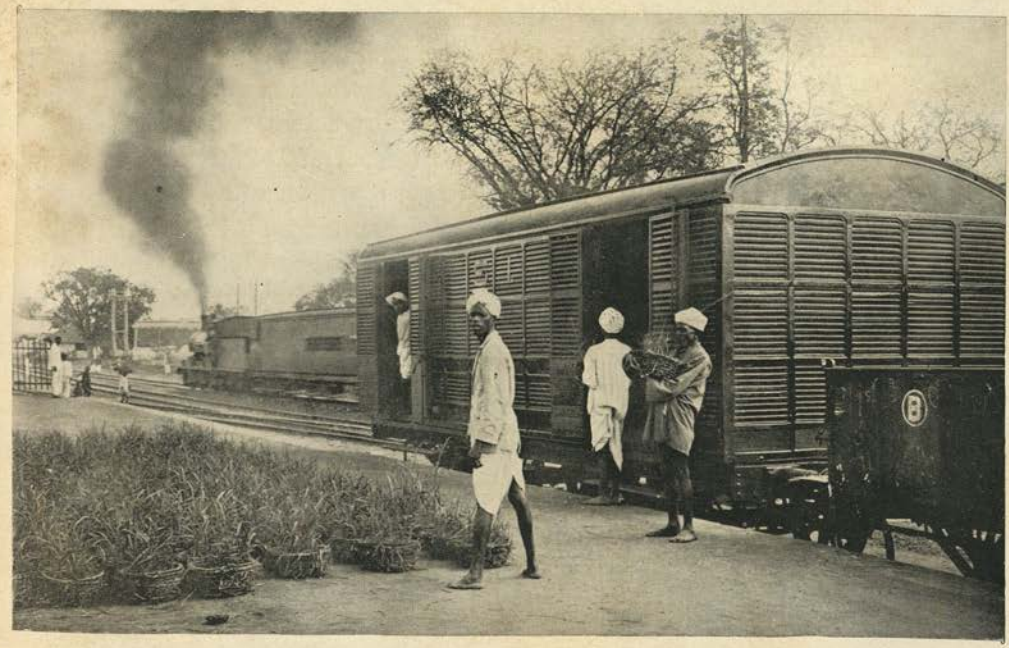
The world production of sugar in the year 1932-33 as given by Messrs. Willet and Gray amounts to 24,138,743 tons, compared with 26,377,334 tons during the previous year, a decrease of 2,238,591 tons. The improvement in the tone of the market

that was visible in the closing months of 1931-32 disappeared very early in 1932-33.

The SUGARCANE BREEDING STATION OF THE IMPERIAL INSTITUTE OF AGRICULTURAL RESEARCH AT COIMBATORE continued its work on sugarcane breeding. Some progress was made in the control of the time of flowering of sugarcane with the object of effecting crosses between parents which normally flower at different times. A period of over three weeks was bridged by controlled illumination and by planting at different times and under different soil conditions. In the breeding of medium types for sub-tropical India, complex crosses were effected involving at least three different species of *Saccharum*, one of them being the wild type, *viz.*, *Saccharum spontaneum*. Co. 313 was found a useful parent for introducing both good habit and satisfactory juice quality. In the breeding of " Noble " types, hybrids were made between the best Java canes and the best Coimbatore medium types. The resulting seedlings show that greater vigour and hardiness are likely to result from such combinations. The range of parents in the inter-generic hybrids between sugarcane and sorghum was widened to include useful Coimbatore canes on the one side and various types of sorghum on the other. The wild saccharums at the Station were studied for their morphological and histological characters with interesting results. Other studies during the year 1932-33 included: (1) measurements of pollen grains with a view to establish a possible relationship between size and haploid number and (ii) chromosome numbers in wild saccharums, bud-sports and interspecific hybrids in saccharum. An interesting case of polyembryony was recorded for the first time in a cross between Vellai and C. A. C. 87. In another cross (Co. 400 × Co. 205) a young seedling was noticed which possessed unmistakably two plumules and two radicles. The medium Coimbatore canes, which have won considerable reputation in sub-tropical India, are proving of use in tropical India as well. Three such instances are: Co. 290 on the estate of the Belapur Company, Bombay, Co. 281 on lands attached to the sugar factory at



1. Sugarcane seedlings in earthen pans and hardened for the railway journey from Coimbatore to Karnal.



2. Loading cane seedlings into the through railway wagon at Coimbatore.

Sugarcane seedlings landed at Karnal after the Railway journey of 72 hours.

Nellikuppam in South India and Co. 213 which has shown remarkable powers of growing under indifferent conditions in the vicinity of the Sugarcane Research Station at Anakapalle. Certain of the seedlings which germinated at the Karnal Sub-station showed sufficient promise for preliminary trials outside Karnal. These have been termed Co. K. Series to indicate that they were bred at Coimbatore (Co.) and selected at Karnal (K).

The Coimbatore canes have received increasing recognition in foreign countries. In Queensland both Co. 281 and Co. 290 are reported as highly resistant to the gumming disease. In Natal, Co. 290 has proved a vigorous grower nearly everywhere and has shown a high degree of immunity to both mosaic and streak diseases.

Under a scheme financed by the Imperial Council of Agricultural Research, for trying new canes at Shahjahanpur from their seedling stage, one more batch of five thousand seedlings was despatched to that place during 1932-33. A similar batch was also sent to the Sub-station at Karnal. This involved that development of a suitable teachnique for transporting the delicate seedlings from Coimbatore to places in Northern India covering a distance of over 2,000 miles.

The recent expansion of the sugar industry has brought work on cane at the IMPERIAL INSTITUTE OF AGRICULTURAL RESEARCH, PUSA, into greater prominence. The increase in cane cultivation caused by the almost universal drop in prices of crops has brought to the front several other problems which hitherto were not regarded as pressing. The extension of the crushing season of factories has made it clear that the industry needs not only an early cane but also a late one and at present a great deal of money is being lost over cane which has gone back in quality through being unable to stand into April and May. This need was foreseen and experiments with a cane of this type have been conducted at Pusa during the last three years. Work on Co. 281 as a cane suitable for irrigated areas in Bihar under factory control, has now reached the estate scale. During 1932-33 selected varieties of cane were planted on a field scale. Some varieties were also under multiplication

and under observation in the nursery. The following canes have completed their field tests and are being examined for minor points as to their suitability for various areas—Co. 299, Co. 313, Co. 331 and Co. 285. Co. 299 is practically as early as Co. 214 and far superior to it in tonnage. Co. 313 is another promising variety which requires fuller study as regards its behaviour to mosaic. Co. 331 represents the type of late cane required for April and May crushing as it gives a high tonnage and can stand much longer in the field without deterioration than any other variety now grown on an extensive scale in the tract. Co. 285 represents the most suitable cane for water-logged areas, but the distribution of this cane has now been suspended as ample supplies of Co. 210 and Co. 213 are available to the mills and the extension of cane-growing to poor land is no longer desirable. Another problem of great importance to cane-growers is the preservation of seed of early canes of the Co. 214 type in the field as great damage is done to the seed-cane crop by jackals. The trashing of such early canes for seed has been successfully accomplished and further work is in progress. Co. 303 and 322 are liable to lodge, but they have been retained for the present to see the effect of interlocking experiments with Co. 213 in preventing lodging, Co. 337, 338, 343 and 304 are still under observation. Co. 300, 301, and 302 were discontinued as they failed to compete successfully with early and mid-season standard varieties. Co. 312, Co. 316, Co. 317, 318 and 319, Co. 326, Co. 335, Co. 340, 341, 342, 345, 346 and 349 were rejected and dropped for various reasons. Co. 351 to Co. 357 sorghum hybrids were expected to ripen in six months' time from the normal date of planting, but failed to do so in this tract. P. O. J. 2878 has been finally discarded on account of stunted growth and unsuitable agricultural habit.

Manurial experiments were also conducted on Co. 210 with superphosphate and oil-cake, diammonphos and the standard manure, oil-cake alone, sulphate of ammonia and nitrate of soda. Manurial experiments on Co. 213 were also conducted with mustard cake, sulphate of potash and superphosphate.

In the UNITED PROVINCES the area under improved varieties of sugarcane during 1932-33 was 73 per cent. of the total area. Rapid progress has been made in the Meerut, Rohilkhand, Agra, Lucknow, Gorakhpur and Fyzabad Divisions where these improved varieties occupied 89 per cent., 78 per cent., 67 per cent., 74 per cent., 79 per cent. and 64 per cent., respectively, of the total area under cane. The total area under sugarcane and the area under improved varieties show a substantial increase over the preceding year. In addition to the standard canes, Co. 213, Co. 290, Co. 244, certain other canes are coming into cultivation, of which possibly the best are Co. 312 and Co. 300. The former is regarded by many in respect of tonnage and other characters as probably the best all-round cane introduced since Co. 213. It has, however, a tendency to lodge under intensive cultivation and flowers readily. Co. 300 is a fine cane with high sucrose content and good purity, but is extremely soft and liable, on this account and its sweetness, to a good deal of animal damage. Another cane Co. 313 is of considerable promise as one of the highest yielders under good farming conditions as yet produced, but it has been withheld from introduction as stocks at most farms are found to have mosaic. Co. 244 is still the poor man's cane of the Western Circle of the United Provinces. The sorghum hybrid varieties are still under examination. One or two show some indication of being effective canes; but it is not certain that any of them will come up to original expectations.

In BIHAR AND ORISSA the spread of Coimbatore varieties of sugarcane has been increasing during the past five years. In Bihar proper about 80 per cent. of the cane acreage is under improved varieties, and they are spreading so rapidly that very soon local varieties are likely to be completely ousted. In North Bihar the development of the white sugar industry has given a great impetus to the extension of cane area. Varietal trials on this crop continued on all farms. Sepaya had some forty-six Coimbatore seedlings under trial, South Bihar seventeen and Orissa about twelve. For North and South

Bihar conditions a preliminary selection of early, mid-season and late canes has been made and field trials have been started. In Orissa, the value of the method of mud planting of hardy canes, such as Co. 205 and Co. 285, has been confirmed. Elaborate manurial trials to find the optimum dose of nitrogen for the heavy rich lands of South Bihar, have been started at the Patna Farm. In North Bihar 40 lbs. nitrogen combined with 50 lbs. P_2O_5 gives indication of being the most economical dose. Very heavy crops of both plant and ratoon canes were raised on the farm in Chota Nagpur with 80 lbs. nitrogen. As the outcome of a grant from the Imperial Council of Agricultural Research, a sugar research station has been opened at Mushari five miles from Muzaffarpur. The primary object of the scheme is the introduction of improved sugarcane varieties either by selection or by breeding to suit different conditions prevailing in the province and to meet the requirements of the white sugar industry in the way of early, mid-season, and late canes. The following work on sugarcane was done at the Mushari Research Station during 1932-33. Some forty Coimbatore seedlings were under observation and trial. For twenty of the most promising ones, complete growth histories have been worked out. From these it appears that sugarcane has two growth maxima—one about early July and the other towards the end of August or early September—depending upon whether a variety is early or late. Studies on soil moisture show that when this falls below 5·7 per cent. in the first foot, the growth of cane in North Bihar soils appears to cease. Physiological investigations have centred round detailed studies of the foliage and roots in relation to environment. The physical properties of soils appear more important than the chemical ones in determining the development of root-systems. The adaptability of absorbing apparatus through the periodical flushing of new roots has indicated important lines of work on which manuring, irrigation, and other cultural operations can be based. Aerotropism appears to have significance in determining which varieties are resistant to water-

logging. The leaf-blade behaviour of some of the varieties is indicative of their capacity to drought resistance. Comparative study of the respiratory quotient and pressure of roots has explained why certain varieties of cane, *e.g.*, Co. 210, always do better in years of scanty rainfall and on light soils. The ultimate yield of sucrose seems to be dependant to some extent on the number of functioning leaves which a variety maintains during its life-cycle. Chemical work consisted of routine analysis with the polariscope at regular intervals to study the progress. The hand refractometer has been extensively used to determine the possibility of devising short-cut methods to ascertain chemical performance of seedlings without elaborate juice analysis. A preliminary sampling technique for obtaining representative samples from cane nurseries and observation plots for analysis purpose has been devised. The very important question of the deterioration of canes after harvesting has been taken up in detail and its relation to the type of cane, its age, hardness of rind, character of pith, germination capacity and soaking or water-absorption capacities is being studied. Successful setting of viable seeds in a number of varieties has been obtained under controlled temperature and humidity conditions. Detailed studies on the flowering habits of cane varieties were undertaken and as a result viable seeds have been obtained of the following crosses :—Co. 300 × Co. 326, Co. 312 × Co. 326, Co. 312 × Co. 346, Co. 312 × Co. 285. Self-fed seeds have been obtained of Co. 205, Co. 285, Co. 323, Co. 312, Co. 326 and Co. 346.

Work on the design of a power-driven sugarcane-crusher in Bihar for which the Imperial Council of Agricultural Research made a grant was started in 1931. In 1931-32 the first experimental mill was manufactured and extensive trials suggested certain minor changes in the design. These were incorporated in a second experimental mill which was manufactured during the year 1932-33 and tested during the last crushing season. The mill has come out successfully from these tests and the design has therefore been standardized. During the trials of

the first experimental mill it became obvious that the mill, although excellent from the point of large growers, was perhaps too big for cultivators having a small area under cane. It was, therefore, considered desirable that another mill of a somewhat similar design, but of more compact type and having about half the capacity was likely to be more in demand. Such a mill will also require a much smaller and therefore less expensive power plant. The design was approved by the Sugar Technologist to the Imperial Council of Agricultural Research and the construction of the first experimental small mill was taken up. The short period over which it was tested indicated a few minor defects. The manufacture of a second experimental mill was then taken up. At the Patna Farm work carried out on a single-pan furnace for producing *khand* and on a similar method of making brown sugar instead of *gur*.

In the PUNJAB Coimbatore canes continued to grow in popularity steadily, and it was estimated that of the total area under sugarcane in the province over 31 per cent. was sown with these improved varieties. The variety Co. 285 is at present the principal cane recommended by the Department, because of its high yield, but the experimental work in progress indicates that before long the Department will be in a position to recommend certain other higher-yielding varieties. An analytical survey of the varieties grown was continued in the main sugarcane districts, *viz.*, Sialkot, Gujranwala, Amritsar, Gurdaspur, Hoshiarpur and Jullundur, and Co. 285 was found to be the heaviest yielder under zamindari conditions. Co. 281 and Co. 313 were least affected by frost, and Co. 312 which has been newly introduced seems to have an assured future. Co. 223, which at one time was regarded as one of the best quality canes, is now going out of favour owing to its susceptibility to disease and to attacks by pests. The incidence of sugarcane borers was controlled by the removal of dead hearts and by the introduction of sanitary fluid after removing them. Following the trials of certain power cane-crushers financed by the Imperial Council of Agricultural Research, a new cane-crusher believed to be

suitable for Punjab conditions has been designed, a trial mill has been made up and will be tested out during the coming sugarcane-crushing season. Experiments were carried out at the Jullundur Farm on the open-pan manufacture of white sugar. Molasses are rich in potash and, as large quantities are now becoming available as a by-product in the sugar industry, a study was made of the effect of composting molasses to find out the amount of potash rendered available under this treatment. A series of comparative experiments, involving the use of molasses and other potassic manures, was started on two different soils.

Most agricultural stations in the MADRAS PRESIDENCY had a large number of varieties of sugarcane under test but the Anakapalle Agricultural Experiment Station specialises in sugarcane work. A varietal study according to manurial and irrigational requirements has indicated that the two best canes were M. A. 21, a seedling cane raised at Anakapalle, for liberal manurial and irrigational treatment, and Co. 213 where water and manure are restricted. The latter is being grown elsewhere too as a drought-resisting cane and has been the most popular of all. At Samalkota, 34 new seedling canes have been studied: here also Co. 213 is most promising. At Palur, Anakapalle, Samalkota and on two other stations, sorghum hybrids were under preliminary trials. At Anakapalle these seems to take as long as nine months to mature, but the same varieties seem to be ready in 7½ months at Palur. At other farms these hybrids seem to mature in between seven and eight months. Experiments are also in hand to find out whether varieties other than sorghum hybrids have more than one ripening season as is known to be the case in a few areas and what are the most suitable months for growing different varieties in different tracts. In an irrigation experiment at Anakapalle it has been found that by irrigating only at the time of planting, Co. 213 under February and April planting gave 37 and 52 per cent. increase in yield over J. 247, respectively, while in M. A. 21 the increase was 15·5 and 33 per cent., respectively. At Palur, experiments

which have been in progress for the last five years indicate that the local standard variety (Fiji B.) responds most to heavy manuring of 200 lbs. nitrogen per acre in the shape of oil-cake and ammonium sulphate in the proportion of 3:2. It is also found that the application of manures in three doses is preferable to one or two doses. The efficacy of ammonium sulphate as a manure for cane compared to groundnut cake when used in conjunction with farmyard and other organic manure was demonstrated at Anakapalle. Over four years ammonium sulphate gave an average net profit of Rs. 63 per acre as against Rs. 22 for groundnut cake. A rotation experiment has been in progress for the last nine years. The results have shown that it is detrimental to the soil to grow cane in alternate years and that it is more economical to grow it once in three years, while still better yields are obtained by growing it once in four years. Experiments on relative resistance of different varieties to sugarcane-mosaic were continued. Twenty varieties of canes were grown inter-stripped with diseased Co. 213 material. Eight varieties proved highly resistant, whilst four proved susceptible. The experiment to determine the loss due to the attack of mosaic was repeated and the results obtained are in conformity with those obtained last year. The reduction in sucrose was not so marked, but the reduction in weight of canes is considerably higher.

In BENGAL sugarcane has established its value as a substitute money crop for jute. It is estimated that improved varieties of sugarcane are now grown on an area of $1\frac{1}{4}$ lakhs of acres. Co. 312, Co. 270 and Co. 285 were best in general habit and growth. P. O. J. 2878 continued to harden and was not much affected by borers. Trials of Co. 213 on mid-*aman* paddy lands were generally successful. The demand for cuttings of Co. 213 sugarcane has increased. A survey of sugarcane cultivation has shown that compact areas can be found in various parts of the districts of Rangpur, Bogra, Rajshahi, Dinajpur and Malda in the Rajshahi Division, Faridpur, Dacca and Mymensingh in

the Dacca Division, Nadia, Jessore, Murshidabad and the 24-Parganas in the Presidency Division and Burdwan in the Burdwan Division, where the local supply of cane is sufficient for the establishment of up-to-date sugar factories. The cane-crushing mill designed by the Agricultural Engineer was further improved with satisfactory results; its capacity was not below thirty maunds of cane per hour while forty-four maunds was the maximum, the maximum extraction rose to seventy-four per cent.

The area under sugarcane in BURMA is small, but there are indications that owing to the low price of paddy, increased interest is being taken in the crop. At the Pyinmana Agricultural Station a great deal of useful information has been collected regarding fertilizers and cultivation methods with this crop and several varieties of valuable exotic canes have been imported. Of the new introductions, the Java cane P. O. J. 2878 grown on a block of five acres gave a yield of 223 tons of stripped cane after one year's growth and from one acre of this block 2,246 *viss of jaggery* was produced. The new Coimbatore seedlings, *viz.*, Co. 402, Co. 408 and Co. 414, have been introduced for trial. Cane seedlings raised in 1931 for further testing were multiplied. In a fertilizer experiment it was proved that the addition of 15, 30, 45 and 60 lbs. of nitrogen (sulphate of ammonia) per acre gave increased yields of canes of 11 per cent., 20 per cent., 32 per cent. and 42 per cent., respectively, while the addition of similar quantities of phosphate in the experiment did not enhance the yield of the cane nor did it expedite ripening. No mosaic disease of sugarcane was discovered on the experimental farm at Pyinmana, but some was found on the cultivators' plots. A banded sclerotial disease was observed for the first time in Burma on exotic sugarcane varieties, but did not cause any great damage. The work on the Jorhat Farm in ASSAM consists mainly of acclimatization and selection of varieties of cane under chemical control as well as cultural and manurial experiments. Of the canes received from Coimbatore in 1929, Co. 243, Co. 290 (thin canes) and P. O. J. 2878 (a thick cane) have done

well in the field trials and have been issued to cultivators. Co. 312 and Co. 214 have been discarded. Of the five varieties received in 1931, Co. 361 and Co. 363 appear promising. Of the twelve Coimbatore canes received in 1932, Co. 407, Co. 408 and Co. 413 promise well. Sixteen new Coimbatore canes were received in March 1933 for trial. All these are thick canes and include some sorghum crosses. The following varieties were grown as plant canes for comparison : H. 109, Co. 290, P. O. J. 2878, Co. 291, P. O. J. 2725, Co. 210, P. O. J. 2714 and Co.243. The previous year's plant canes with the exception of Co. 223 and Co. 291 were ratooned. The results of the chemical analysis of the experimental canes, both plant and ratoon, were briefly as follows. As a plant cane, Co. 290 gave the highest yield both of stripped cane and sucrose followed by P. O. J. 2714 and P. O. J. 2878. As regards the quality of the juice P. O. J. 2714 was the best, followed in order by P. O. J. 2878 and Co. 290; these three varieties being found to be distinctly superior to all others. Co. 243, a new promising variety, gave almost as heavy outturn of cane as Co. 290 but due to the poor quality of the juice the outturn of sucrose was low. P. O. J. 2725 gave a fair outturn of cane and sucrose per acre and is a hopeful variety. H. 109 and Co. 210 gave good crops but the outturn of sucrose was low. Co. 291 gave the poorest crop and its yield of sucrose was decidedly poor. Of the ratoon canes P. O. J. 2714 gave the heaviest yield of sucrose per acre, closely followed by Co. 290 and H. 109. Co. 213 and Co. 210, although giving heavier yields of stripped cane than P. O. J. 2714, failed to give a satisfactory outturn of sucrose due to inferior quality of the juice. D. 74 and B. 6308 which gave poor crops also gave the poorest yield of sucrose; these two varieties are very late ripeners, P. O. J. 1547 gave the lightest crop but was the best as regards the quality of the juice, and consequently gave a heavier yield of sucrose. All things considered, P. O. J. 2714 was the best cane closely followed by Co. 290. The average yield of *gur* per acre over the whole Farm was 4,953 lbs. per acre against 4,228 lbs. in the previous year. The average out-

turn per acre of the experimental crop was 28·26 and 26·76 tons of stripped cane for the plant and ratoon canes, respectively, against 20·6 tons and 26·79 tons in the previous year.

The average yield per acre in the Kopargaon Farm in BOMBAY was 10,888 lbs. of *gur* for plant cane and 8,738 lbs. of *gur* for ratoon cane as against 12,010 lbs. of *gur* for plant and 6,258 lbs. for ratoon during the last year. As regards varietal trials the variety D. 109 has been dropped this year; P. O. J. 2878 in ratoon has given the best results as a ratoon, E. K. 28 coming next. The appearance of the ratoon P. O. J. 2878 was very impressive. Co. 290 thrives well in low-lying situations while H. M. 89 is an early variety, non-arrowing and erect. Four factories in the Bombay-Deccan have large areas under E. K. 28 and P. O. J. 2878 and the total area may exceed 4,000 acres. The varieties H. M. 320 and the new sorghum cane hybrids have been tried at Belvandi and Belapur and some of these are very promising. Four years' experiments on the nitrogen requirements of the local Pundya cane have now been completed and the results are of interest. The average yields of cane both in plant and ratoon increased with increasing doses of nitrogen and the same was true of the *gur* yields from plant cane, but with ratoons 150 lbs. nitrogen gave a higher yield of *gur* than 200 lbs. The economic dose will probably be 150 lbs. nitrogen but further trials are necessary. At the Kopargaon Farm comparative trials of the improved methods (modified Manjri Farm system) *versus* the local method of planting cane were continued; these showed that the cost of cultivation by the local method is the higher. A study of the culminating point in the ripeness of cane has been in progress for the last three years at Hol. Tests were made at intervals of ten to twelve days and the weight of cane, extraction, brix-weight of *gur* and the ratio of *gur* to juice and cane was systematically recorded for two varieties, *viz.*, E. K. 28 and Pundya. In 1932-33 the best time for harvesting of E. K. 28 was 12 months and eight days after planting and for Pundya 13 months and 20 days. For years

1930-31 and 1931-32 the corresponding figures for Pundya were 13 months 20 days and 12 months and 24 days, respectively. While the exact period will depend on the date of planting, the nature of the season and the manure applied, it can safely be concluded that Pundya required 13 months for complete ripening under Deccan Canals conditions. During 1932-33 the laying out of land and the fitting up of the laboratory for the Deccan Sugarcane Research Station was completed. This experiment station is situated at Padegaon on the Nira Left Bank Canal, and is financed by the Imperial Council of Agricultural Research.

In the CENTRAL PROVINCES the Coimbatore canes Nos. 219 and 237 are popular in the Betul district, but throughout the Southern Circle of the CENTRAL PROVINCES as a whole Co. 210 is the most suitable variety.

During 1932-33 the total area in the NORTH-WEST FRONTIER PROVINCE under this crop was 53,212 acres, but this area could easily be more than doubled if proper marketing facilities were provided. The experiments on varieties grown in 1931-32 at Tarnab were continued during 1932-33. Most of the area is under Paunda and Assam Red which have done fairly well in the past. Among the new varieties, Co. 285, Co. 360 and Co. 210 appear to be promising. At the Haripur Farm Co. 213 and Co. 290 were ratooned for the second year. The *gur* yields from both the varieties decreased in the year 1933, compared to their yield in 1932. Co. 290, however, which is an early maturing cane gave better results than Co. 213. In this tract canes are generally ratooned for three years and if the results of the third year also are in favour of Co. 290, the zamindars will be advised to substitute this variety, Co. 290, for Co. 213.

5. Jute.

The estimated area under jute in 1931 was 1,862,000 acres and, in 1932, 2,143,100 acres. This was a very considerable reduction on the area of 1930, which was 3,492,000 acres, and was brought about by intensive propaganda for the restriction of sowings by the Government of Bengal. The action was

necessitated by the slump in prices consequent on the accumulation of stocks and falling demand. Some increase in the prices obtained for the jute by cultivators resulted, but even so the prices were far from satisfactory. The difficulties of the position were increased by a dispute over working hours between outside jute mills and the Jute Mills Association. Fortunately, an agreement was evidently come to, which steadied the market. The position of many cultivators was still very serious and they were unable to pay their rents and debts, thus causing considerable distress amongst the middle classes. The position has been further aggravated by the use of other fibres for fabrics usually manufactured from jute. This has been due largely to the low prices ruling for all fibres; and fibres which normally, because of high cost, could not compete with jute, were used so as to find an outlet for the heavy stocks in hand. The development of substitute cash crops for jute has in consequence received special attention.

The quantity of Departmental jute seed sold direct to cultivators in Bengal through the Government selling agent was considerably reduced, but it is estimated that fifty per cent. of the area under jute is now sown with Departmental races.

Experiments were continued by the Fibre Expert in the production of new types by selection and hybridisation, and several of these appear to be very promising. D. 154 (white jute) and Chinsurah Green (*C. olitorius*) are still the heaviest yielders in their respective classes.

6. Other Fibres.

Hemp. The areas under different kinds of hemp are not recorded annually in detail but so far as known were as follows:—

Province	Sann-hemp (*Crotalaria juncea*)	Bombay-Deccan or *Ambari* hemp (*Hibiscus cannabinus*)	Other hemps (including *Cannabinus sativa*)
	Acres	Acres	Acres
Madras	1,13,860	52,276	435
Bombay	35,618	63,324	904
Bengal	52,000	Figures not obtainable.	
United Provinces	1,74,880	..	78
Central Provinces	44,214	34,996	..
Bihar and Orissa	14,400	..	105
Total (principal producing provinces)	4,34,972*	1,50,596	1,522

* Not all of this area is grown for fibre, as sann-hemp is also an important green-manure crop.

At PUSA the study of crosses with the new *Hibiscus* (*H. sabdariffa* var. *altissima*) was continued, and the F_2 generations of the two crosses, *Albus* × new *Hibiscus* and *Ruber* × new *Hibiscus*, were grown. In both the crosses the ratio of bushy plants (like *Albus* or *Ruber*) to non-bushy (like new *Hibiscus* and F_1) was 1 : 3, and that of broad-leaf-lobed plants (*Albus* or *Ruber*) to narrow-leaf-lobed plants (new *Hibiscus* and F_1) was also 1 :3, suggesting a mono-hybrid segregation.

As regards stem colour in the cross *Albus* × new *Hibiscus* the ratio of red plants like the F_1, red plants like the new *Hibiscus* and plants like *Albus* was as 9 :3 :4, suggesting a di-hybrid segregation, while in *Ruber* × new *Hibiscus* the proportion of red plants to plants like the new *Hibiscus* was 3 :1.

A number of F_2 plants have been selfed for the study of the F_3 which it is hoped will throw further light on the inheritance of the various characters.

The Fibre Expert to the Government of Bengal reported that at DACCA the new Pusa *Hibiscus* (*H. sabdariffa* var. *altissima*) gave the high yield of 27 maunds per acre on a soil which was not particularly fertile. The fibre grown and retted at Dacca was examined in Calcutta at a meeting by balers, spinners and brokers and the general opinion was that the fibre is spinnable but would not be regularly accepted by mills for making gunnies. It was placed in the same class as "*mesta*"—*H. cannabinus*—and considered more suitable for rope-making.

A sample was also sent to a firm of rope manufacturers to test its suitability as a cordage fibre. The rope had a breaking strain of 12 cwts. as compared to the official standard of $15\frac{3}{4}$ cwts. for a manila rope of the same dimensions.

Sann-hemp (Crotalaria juncea). During 1931-32, exports of Indian hemp declined by 23 per cent. in amount and 46 per cent. in value from those of the previous year, and for the major part of the year the Indian hemp was in poor demand, because the consumers abroad were all supplied at low prices from other sources. In 1932-33, there was better demand for Indian hemp and exports advanced by 25 per cent. in quantity and 19 per

cent. in value. The exports during the last three years were as follows:—

	Cwts.	Value (lakhs of Rs.)
1930-31	293,000	39·5
1931-32	224,000	21
1932-33	281,000	32

In the last Review mention was made of the enquiry financed by the Imperial Council of Agricultural Research into the condition of the hemp trade and possible improvement in the quality of hemp exported. The recommendations contained in Mr. Sabnis' report were examined by a special Committee, and action is being taken to give effect to the Committee's recommendations. The Advisory Committee on Vegetable Fibres of the Imperial Institute, London, kindly furnished a helpful memorandum on the report, which was examined in consultation with Directors of Agriculture and with members of the trade in India.

In view of the growing importance of sann-hemp, a detailed study and the isolation of a suitable strain was commenced at Pusa. A large number of samples were collected from all parts of India and Burma. These were grown in 1931-32 and single plant selections from this material have been made. Sann-hemp is a cross-fertilized crop not amenable to selfing so that the isolation of pure-breeding type is not a simple matter.

There appeared to be a good deal of variability in the amount of seed setting in the different cultures studied. Whereas most of the Upper-India samples showed good setting, the better fibre-yielding types obtained from Bombay, Central India and the Central Provinces set very little seed under Pusa conditions. This may indicate that, as in the case of linseed there are marked lifferences between the types grown on black soil and alluvial areas.

In the UNITED PROVINCES the improved variety bred at Cawnpore, C.12, has already established its superiority over local varieties both in yield and quality of fibre. The report from the Imperial Institute on the quality of fibre was favourable. Seed of this variety is in demand.

It has been found that to get an effective crop the seed-rate should be between sixty and eighty pounds and that the best fibres are secured when the crop is harvested in full bloom. The time taken in retting depends on the temperature of the water, but in October it should be four to five days.

A great deal of work requires to be done to improve the village methods of handling the crop and the subsequent marketing purposes. The Imperial Council of Agricultural Research has approved several research grants for work of this nature.

Asclepias semilunata. In BENGAL this crop was grown on a large scale at Rangpur, Rajshahi and Berhampore and the fibre was extracted from the bark. The bark from the first two places was good. Samples of the fibre have been sent to Belfast and Manchester for test.

Sisal hemp. Experiments on extraction in Bengal have shown that leaves passed through the ordinary bullock-driven cane mills and then retted in water produce a workable fibre of good strength.

7. Tobacco.

The total area under tobacco in India was 1,257,000 acres in 1930-31, 1,279,000 acres in 1931-32 and 1,212,000 acres in 1932-33. The total yield of dried leaf was 573,000 tons in 1930-31, 623,000 tons in 1931-32 and 608,000 tons in 1932-33. The bulk of the tobacco grown is consumed in the country but, as will appear from the following figures, there is a valuable export trade in unmanufactured leaf:—

Exports of unmanufactured tobacco.

Year	Quantity in million lbs.	Value in lakhs of Rs.
1930-31	28	97
1931-32	25	81
1932-33	21	73

The United Kingdom continued to be the best market for Indian tobacco which enjoys a preference in that country.

The extent to which imports of ready-made cigarettes are being replaced by those of unmanufactured leaf for use in Indian factories is shown by the following figures:—

Year	Imports of unmanufactured tobacco in million lbs.	Imports of cigarettes in million lbs.
1930-31	1·5	3·1
1931-32	2·8	1·4
1932-33	5·1	1·0

There is a marked opening for the greater production of cigarette tobacco in India and fortunately the production of light bright leaf of the Virginian type by flue-curing, which was initiated in the Botanical Section at Pusa in 1926, has now reached a stage at which it ranks as an important industry in those tracts which are suitable for the cultivation of this type of leaf. Many hundreds of flue-curing barns are now in operation in India and training for the staff of provincial departments of agriculture in flue-curing is provided for by annual courses in the Botanical Section at Pusa.

A paper describing eighteen new types of indigenous tobaccos was published from PUSA: this extends the work of a previous publication in which types 1 to 51 were dealt with. A study of sterility in Pusa type 56 was completed. In this type there is a heavy amount of flower-shedding in the early stages of growth which is succeeded by good seed-setting in the later stages; the viability of the seed is, however, not quite so high as in other types. The physiological causes of this have been investigated and the results will shortly be published.

Further curing tests with Hybrid No. 142 were carried out, and confirmed the results obtained in the previous season, but owing to the severe incidence of leaf-curl disease in 1932-33 no definite conclusions could be drawn as regards the yielding power of this type. The cause of this disease is obscure; it may possibly be a virus disease. The last serious outbreak at Pusa was in 1925-26.

In the Chemical Section at Pusa a comparison was made of two methods of rack-curing, *viz.*, when the leaves are removed from the stalks prior to curing and when the leaves are cured with the stalks. Two kinds of tobacco, Adcock and Pusa 28, were cured on racks in each way and the cured products examined for nicotine, sugar, starch, amido and albuminoid nitrogen. The results for nicotine content have been completed and show that the tobacco leaf cured in the stalk has a higher nicotine content.

In the MADRAS PRESIDENCY tobacco is grown in two distinct tracts, one in Guntur and the other in Trichinopoly. Virginia tobacco varieties are reported to be popular with the ryots in Guntur. Flue-curing has become quite a common feature, and this is the leading district in India in this respect.

In the BOMBAY PRESIDENCY there are 3,114 acres under the improved tobaccos Nos. 6 and 28. Work at the Tobacco Experiment Station at Nadiad includes the production of a strain suitable for cigarette tobacco and improved methods of growing and curing. Trials have shown that G. 6 is the best strain in the Gandiu variety, while P. 45 and P. 28 are the best strains isolated from the Piliu variety. Two promising cultures from a cross from Gandiu No. 6 and Bengi have been produced and also another strain of a cross between Gandiu 6 and Adcock. All these hybrids are under trial.

Nipping at about twenty leaves per plant was found to give the thinness of leaf required for cigarette tobacco. By a slight change in the local method of curing, a fairly bright leaf suitable in colour and texture for cigarette blends has been produced, but the tobacco contained a high percentage of nicotine.

In BENGAL work on tobacco was continued at the Government Tobacco Farm, Rangpur, and in addition arrangements were made to produce seed at several farms throughout the province to meet the local demand. The exotic varieties introduced by the department are reported to be spreading in the Rangpur area, the main crop being Sumatra for wrapper and Pennsylvania and Manilla for fillers. The departmental

selection called Matihari has found favour with the cultivators as a good *hookah* tobacco. Among the exotics tried at Dacca, Ohio seems to have distinct possibilities as a pipe tobacco and is suited to heavy soils. Among the local varieties Matihari has been found to grow well, when sown as a late crop.

Work on cigar-making was continued successfully and a good local sale has been organised. A simplified method of fire-curing appears to have possibilities and cured leaf of the Ohio variety produced by this method was reported on favourably. An effort is being made to find better markets for high-grade leaf, and preliminary information for a tobacco survey of the province has been collected. The seed distributed to cultivators in 1931-32 and 1932-33 amounted to 1,764 tolas and 2,900 tolas, respectively.

Work on tobacco in BURMA is confined to the small area of riverine land at Saaing which is an annexe to the Allanmyo Agricultural Station. The tobaccos grown at the Station consist of three groups:—Pennsylvania and Manilla varieties, Burmese types and Matihari. The first group being light in colour is suitable for cigarettes, the second mainly for cheroot fillers and the third for the strongest type of cigars. Pennsylvania has been found to be the best for wrapper leaf and Manilla as a filler. Experiments on effect of age on flavour showed that 'ageing' was of value only up to the following season.

In BIHAR AND ORISSA this crop is reported to be spreading in the Sambalpur District. The new Pusa hybrid (H.177) was subjected to a series of trials with Pusa 28, at the Sabour Botanical Section. In the 1931-32 trials, the hybrid was not superior to the local variety, but proved a high yielder in 1932-33.

In SIND the cultivation of tobacco, both for *bidi* and cigarette manufacture, offers good prospects under Barrage conditions of cultivation, the main difficulties at present being damage by frost, and inexperience of curing methods, especially for the better-quality types. An Assistant was deputed to Pusa for training in tobacco-curing. Six imported varieties

were tried at Sakrand and though the crops were seriously damaged by frost, sufficient seed for further trials and distribution has been obtained. The Gujarat variety Gandiu No. 6 was tested during 1931-32 and grew vigorously.

In the NORTH-WEST FRONTIER PROVINCE, tobacco was grown at the Tarnab Agricultural Station, and manurial experiments were laid down with a view to finding out the value of potassium sulphate. An increase of yield was obtained but the experiments will have to be repeated on more accurate lines.

An interesting development in the Western Circle of the UNITED PROVINCES has been the move towards tobacco-growing in the Saharanpur District. With the introduction of the new flue-curing process, the light soil of a considerable area of this district seems capable of producing a high-quality, pale-yellow, Virginian cigarette leaf, which is likely to command a good market. The crop occupies the land only for three months and can be grown without irrigation. Further experimental work is required.

A collection of various types of tobacco both imported and indigenous has been made in the PUNJAB. Three of the selections made at Lyallpur from indigenous tobaccos are promising. No. 12 gave an average increase of 11 mds. per acre over the local tobacco, and is appreciated by the cultivators. Manurial experiments have shown that the application of farmyard manure, ammonium sulphate and sodium nitrate are all profitable and that sodium nitrate pays better than ammonium sulphate. Farmers have begun to purchase artificial manures for this crop. On account of the low prices of wheat and cotton, this crop is attracting some attention in the Montgomery District.

In the District of Campbellpore so much damage is done to this crop by a pest called *Kumb* (Broom-rape) (*Orobanche cernua* and *O. indica*) that tobacco-growing had to be given up on certain lands. Hoeing the fields prevents the pest from forming seeds and an intensive campaign having been undertaken, 515 acres have been cleared of the parasite. This

parasite is a non-chlorophyllous flowering plant and its life-history and parasitism were fully described by Shaw in 1917 (*Mem. Dept. Agri. Ind. Bot. Ser.* IX, 3).

8. Oil-seeds.

The estimated area and yield of the principal oil-seeds in 1931-32 and 1932-33 as compared with 1930-31 are shown below :—

Oil-seed	1930-31		1931-32		1932-33	
	Area in thousands of acres	Yield in thousands of tons	Area in thousands of acres	Yield in thousands of tons	Area in thousands of acres	Yield in thousands of tons
Rape and mustard .	6,632	988	6,220	1,025	6,079	1,052
Linseed . .	3,009	377	3,309	416	3,250	405
Sesamum . . .	5,618	526	5,639	476	6,025	547
Groundnuts . .	6,579	2,767	5,489	2,276	7,005	2,934
Castor . . .	1,457	120	1,583	146	1,602	149

In 1931-32 and 1932-33 the production of cotton was estimated at 4,007,000 bales and 4,512,000 bales, respectively. The corresponding output of cotton seed calculated at 0·36 ton per bale may be estimated at 1,442,000 tons and 1,624,000 tons.

Exports of oil-seeds from India.

Oil-seeds	Thousands of tons			
	Pre-war average	1930-31	1931-32	1932-33
Linseed	379	257	120	72
Rape-seed	273	33	54	115
Groundnuts	212	601	672	433
Castor	114	91	104	86
Cotton-seed	240	41	12	2
Sesamum	119	1	12	10
Copra	31	..	..	..
Others	85	13	14	15
TOTAL .	1,453	1,037	988	733

The preceding table shows that the years 1931-33 saw a substantial decline in the exports of all the principal oil-bearing seeds with the exception of rape-seed. There has, however, been a substantial increase in the exports of vegetable oils during the triennium but the increase was not equivalent to reduction in exports of seed.

—	1930-31	1931-32	1932-33
Vegetable oil in gallons	1,140,000	1,900,000	2,444,000
Oil-cake in tons	254,000	291,000	287,000

Fortunately the year 1933-34 saw a marked recovery in this important group of exports.

Appointment of an Oil-seeds Committee by the Imperial Council of Agricultural Research. The better utilisation of oil-seeds is of great importance to Indian agriculture and in July 1930 the Governing Body of the Imperial Council of Agricultural Research appointed a Committee to consider the development of the Indian oil-crushing industry. The Committee held a preliminary meeting in May 1931 and the second meeting of the Committee was held in Bombay in December 1931. Action is now being taken by the Council on the Committee's recommendations. Among the various lines of investigation recommended by the Committee, improvement in the yield and oil-content of the principal seeds stood first. The Committee also recommended that experiments should be undertaken on the possibility of using the strong fibre of linseed plants for commercial purposes and the most economic means of utilising cotton-seed.

As a result of the Ottawa Trade Agreement, to which a reference has been made in an earlier chapter, Indian vegetable oils, oil-seeds and oil-cake now enjoy important tariff preferences in the United Kingdom. By the same agreement certain tariff

preferences on Indian vegetable oils were secured in other parts of the British Commonwealth. It was in the circumstances important that steps should be taken to exploit these preferences which had considerable possibilities. In order to consider these and numerous allied questions, a meeting of the Committee was called for in the first week of April 1933. As the action taken on the Committee's recommendations will come within the purview of the next report, it is sufficient to say here that it recommended schemes of research on groundnuts, appointed a sub-committee to consider the proposals received for research work and higher training in the technology of vegetable oils, worked out details for the coconut products enquiry, referred to in a succeeding paragraph, and outlined a scheme for a Central Oil-seeds and Oil-industry Committee. The Committee also recommended the preparation of a Bulletin on standards for vegetable oils and oil-cakes and on various matters connected with the trade in oil-seeds, and this has since been published. The loss to both the domestic and the export trade in groundnuts and groundnut-oil by the damping and wet shelling of groundnuts, was brought to the notice of the local Governments concerned, as this practice leads to an unduly high free fatty acid content, which renders the oil unsuitable for many purposes. The attention of all agricultural departments was drawn to the valuable collection of pure strains of linseed maintained at the Imperial Institute of Agricultural Research, Pusa.

In view of the preferential tariffs of 10 and 15 per cent. which Indian vegetable oils have secured in the markets of the United Kingdom, oil-seeds are now given more attention by the departments of agriculture in India. An Oil-seed Branch of the Botanical Section has been formed at Sakrand in Sind to investigate the cultural and economic possibilities of the extension of improved oil-seed crops in the Barrage areas. This Branch is financed by Sir Sassoon David Trust Fund. An Oil-seed Growers' Association has also been organised with a view to stimulate extension of oil-seed cultivation.

Rape and mustard. The principal provinces for these oil-seeds are :—

	Area in thousands of acres	
	1931-32	1932-33
United Provinces	(*a*) 273 / (*b*) 2,659 } 2,932	327 / 2,484 } 2,811
Punjab	1,150	1,158
Bengal	770	716
Bihar and Orissa	645	627

(*a*) Grown as a pure crop.
(*b*) Calculated area, grown as a mixed crop.

The study at PUSA of some crosses of *Brassica* shows that it is possible to secure a self-fertile plant with red seed, thus explaining the nature of the red-seeded natural crosses which were found to be self-fertile. It is therefore now possible to produce a desirable high-yielding strain of red-seeded, self-fertile *sarson* or *toria*. Preliminary observations were made on the influence of cloudy weather on seed-setting. Some strains of the self-sterile groups were grown at isolated places in order to secure pure multiple strains.

In the PUNJAB the Oil-seed Botanist continued his study of this crop. Mass selection has resulted in strains which give increased yields over unselected seed. As a result of inter-crossing between the yellow and the brown-seeded forms of *sarson*, two brown-seeded, self-fertile plants have been obtained from which it is hoped to obtain a high-yielding self-fertile strain. An attempt is being made to produce a suitable self-fertile strain of *toria* by inter-crossing between *toria* and yellow-seeded *sarson*. *Toria* plants raised from black seeds are found to be better in all respects than those from red seeds, and an attempt is being made to ascertain the factors which affect the development of colour in the seeds.

In SIND several samples of cruciferous oil-seeds were tried at Sakrand in the *rabi* season. Rape seed proved to be well adapted to the conditions of *rabi* water-supply prevailing in the Barrage area and gave the highest yield, *toria* and mustard coming next. All these crops appear to be well suited for extended cultivation in the Barrage areas and at present prices are more profitable than wheat. Their wide range of sowing periods is an additional advantage under Barrage conditions.

Linseed. The area under linseed in India is on the average of the last three years 3,156,000 acres, the chief linseed-growing provinces being as follows :—

Area under linseed in thousands of acres.

—	1930-31	1931-32	1932-33
United Provinces	(*a*) 310 } 954 (*b*) 644 }	321 } 910 589 }	228 } 852 624 }
Central Provinces	739	937	1,008
Bihar and Orissa	654	662	641
Bengal	116	126	125
Hyderabad State	253	306	269
GRAND TOTAL	3,009	3,309	3,299

(*a*) Grown pure.
(*b*) Grown as a mixed crop : calculated area.

Economic work on linseed is carried on at Pusa and in several provinces mentioned above. The recent work at PUSA is described elsewhere in this report (page 152) and has been directed towards the production of hybrids of good yield and high oil-content.

In the UNITED PROVINCES strain No. 1150 has yielded on trial plots over fifteen maunds per acre. A number of rust-resisting types with a high oil-content are undergoing field trials on the Research Farm; their suitability for the East United Provinces or Bundelkhand, where most of the linseed is grown, has yet to be demonstrated. Four of the 27 hybrids

tested against strain No. 1150 have been sent to Circle Officers for trial.

In the CENTRAL PROVINCES a selection known as E. B. 3 has maintained its reputation and the demand for its seed is increasing. This strain, in addition to producing a bold seed, has a well-developed and deep-seated root-system, so that it withstands drought conditions successfully, while its early maturity enables it to escape rust. In cropping power it is a distinct improvement on local types. An interesting series of crosses between Irish flax and local linseed, and between Punjab linseed and strain E. B. 3, are under observation, and some of them promise both in regard to yield and resistance to rust.

In BIHAR AND ORISSA, a cross between the Sabour wilt-resistant selection and Pusa Types 12 and 121 is under study.

In BENGAL a survey of Bengal linseed is nearly complete. Yield tests have shown that the selected strain B 14 gives a heavier yield than the Pusa types. Arrangements have been made to make a survey of linseed areas in Nadia and Murshidabad, to make a series of crop-cutting experiments on linseed and other *rabi* crops, and to ascertain the causes of the decrease in the area of this crop.

Sesamum. On the average of the last three years, this crop occupied an area of 5,757,000 acres. The areas in the principal provinces are as follows:—

Areas under sesamum in thousands of acres.

	1930-31	1931-32	1932-33
United Provinces	(*a*) 257 (*b*) 847 } 1,104	330 882 } 1,212	388 839 } 1,227
Burma	1,322	1,308	1,600
Madras	746	747	836
Central Provinces	577	505	604
Hyderabad State	593	508	601
GRAND TOTAL	5,618	5,639	6,256

(*a*) Grown as pure crop.
(*b*) Grown as mixed crop: calculated area.

Preliminary tests with sesamum types isolated at PUSA indicate that Types 3, 7 and 29 will be good yielders. A cross made between Types 3 and 29 is under study. A heavy-yielding white-seeded hybrid is aimed at, as such types yield a lighter coloured and more valuable oil.

In BURMA, a variety called Theikpan Hnan-net has been evolved for the heavier rainfall tracts and is now under distribution. For the lighter rainfall tracts, a variety called Shwetchung is being put down. The Economic Botanist is attempting a cross between early and late sesamums.

In the CENTRAL PROVINCES and SIND, breeding work has recently been started with the object of evolving high-yielding strains containing a satisfactory percentage of oil.

In MADRAS the Oilseeds Specialist has collected fifty-four varieties to study their suitability to different seasons. ' Sattur ' and ' Anakapalle ' have been found to be most promising among the short-duration, irrigated gingellies. Some of the medium duration varieties from Malabar are also promising.

Groundnut (Arachis hypogaea). The area and yield of groundnut during the last three years are given below :—

Year	Acres	Tons of nuts in shell
1930-31 . . .	6,579,000	2,767,000
1931-32 . . .	5,489,000	2,276,000
1932-33 . . .	7,005,000	2,934,000

On the average of the last three years, Madras had 3,241,000 acres, Bombay 1,022,000 acres, Hyderabad 861,000 acres and Burma 498,000 acres.

In MADRAS out of the twenty-five varieties tried by the Oilseeds Specialist, ten have yielded significantly higher yields than the local variety. A variety known as ' Saloum ' which proved superior to the local Mauritius has been issued for district trials. An attempt is being made to obtain by hybridazation high-yielding, short-duration strains of both the bunch and spreading types of groundnuts. It has been found that the percentage of oil increases and the free fatty acid content

decreases as the groundnut kernels develop. Spacing trials showed that 6 in. × 6 in. to be the most economical for the bunch varieties and 9 in. × 9 in. for the spreading type. The flowering period, the rate of formation of oil during growth and the root-systems are also under study.

In BOMBAY the area under improved varieties of groundnuts was 731,981 acres in 1931-32 and 843,803 acres in 1932-33. The improved varieties introduced by the department have spread rapidly in all the groundnut-growing tracts. The Spanish Peanut variety occupies about 423,000 acres in Khandesh, while Small Japanese and Spanish Peanut together occupy about 56,700 acres in the Panch-Mahals District. The Spanish variety has recently been introduced successfully into the Canal zone of the Deccan. On the Nira Bank Canal and in the dry tract of the Poona district, yields varying from 1,200 to 1,700 lbs. per acre have been obtained. The application of superphosphate has yielded encouraging results with this crop.

In HYDERABAD STATE groundnut cultivation has spread very rapidly in the Telingana Division during recent years. The local seed is a mixed variety which is trailing in habit and is consequently very difficult and costly to harvest. Experiments with erect, bunch, types are in progress. One of the varieties under trial, Kanke No. 17, which proved successful, has already been introduced in the villages and is spreading rapidly; Spanish Peanut also appears promising. The department distributed 43,440 lbs. and 125,392 lbs. of improved seed during the two years under review. The advantage of the cotton-groundnut-*juar* rotation over the cotton-*juar* rotation, is being advocated by the department.

In BURMA groundnut is an important crop in the West Central and Myingyan Circles. Of the fifteen varieties tested at the Magwe Seed Farm, Mauritius, Burmese and Pondicherry proved to be superior performers. The difference in yield between the Burmese and the other types being small, it was decided not to replace the Burmese. The erect type introduced by the department has proved useful in the riverine areas on

account of its earlier ripening habit and the ease with which it is harvested.

In the CENTRAL PROVINCES, where groundnut has proved to be the most suitable crop for rotation with cotton, the area under improved varieties is over 128,000 acres. Owing to the general fall in the price of cotton, the acreage under groundnuts in Berar has increased considerably in recent years. In 1922-23 the area was 2,529 acres; in 1931-32 the area was well over one lakh of acres, with the result that a number of mills and oil-expellers for extracting groundnut have been established. The agricultural department maintained 2,156 seed-farms in 1931-32 and 2,389 seed-farms in 1932-33 for this crop, and distributed 66,279 and 66,168 maunds of seed in these years. The recently developed new strain of Spanish Peanut (Ak. 12-24) has proved superior to all other varieties in respect to the size of pods, maturity, oil-content and cropping power. On the Akola Farm it gave an average of 1,400 lbs. per acre as against 1,000 to 1,200 lbs. of the other varieties. About five thousand pounds of the seed of this variety were distributed.

In the PUNJAB several disease-resistant and high-yielding strains are under trial in the district farms. There is considerable scope for the introduction of this crop in certain parts of the province and zamindars in parts of Ludhiana have already taken to this crop.

In BIHAR AND ORISSA the cultivation of this crop is extending in the Sambalpore District, where over 1,000 acres have been put down to it. On account of the falling market and the high cost of harvesting it, however, the cultivation of this crop is decreasing in the Ranchi district. In a varietal trial at the Sambalpore Farm, Kanke 17 was found to be the best.

In the MYSORE STATE a variety known as Valencia has been found to be promising, as it ripens in three months and yields better than either Small Japan or the Spanish. It is found to be specially suited for growing between lines in sugarcane plots. Another variety known as H.G. 1 has come out well in bulk trials.

In SIND thirty-four samples from all parts of India were grown at Sakrand and ten have been retained for further trial. These, together with five other new types, were grown and a detailed plant-to-plant study was made. The Spanish Peanut varieties appear to be best suited for extended cultivation under Sind conditions.

In the NORTH-WEST FRONTIER PROVINCE a number of varieties from other provinces are under trial at the Tarnab Agricultural Station.

In BENGAL groundnuts are studied more as a food crop than as an oil-yielding crop. An attempt is being made to introduce it into suitable localities.

Castor. Over fifty per cent. of the total average acreage of 1,547,000 under castor, is in Hyderabad State, Madras (323,000 acres), Mysore (109,000 acres) and Bombay (73,000 acres) coming next in importance. In the HYDERABAD STATE work on individual plant selection has been continued and many of the plants raised appear to possess the desired characters. It has been confirmed that the sex of the castor plant is almost a hereditary character. An all-India scheme for castor-breeding has been sanctioned by the Imperial Council of Agricultural Research.

In MADRAS the Oilseeds Specialist has distributed seeds of five or six promising varieties to the district agricultural experiment stations for trial.

Coconut (Coconut enquiry). The discussions on the Ottawa Trade Agreement brought into prominence certain important factors regarding the coconut industry in South India. Indian oil-crushers had maintained for some years past that the supply of *copra* (dry coconut kernel) which is the raw material for coconut oil, was insufficient, and had asked the Government of India to reduce the duty on *copra* from Ceylon. The trade figures seemed to indicate fairly clearly that there was a shortage in the supply of coconuts and coconut products, but on the other hand, there were complaints from coconut farmers that the prices of coconut products in South India were unduly low. It appeared that during the past ten years coconut

production in South India had not expanded with any great rapidity, and it was of moment to obtain a correct statement of the position. The Imperial Council of Agricultural Research provided funds for a special enquiry by a whole-time officer in order that real facts might be obtained. The local Governments and Indian States concerned welcomed the proposal, and the enquiry was carried out by Dr. J. S. Patel whose services were lent by the Madras Government. A report has since been published.

In MADRAS the low price of coconut products militated against the extension of coconut cultivation on the West Coast. The department continued to demonstrate the advantage of wide spacing, inter-cultivation and manuring of gardens, and about 900 acres of dry land were planted with coconuts with the advice of the department. The agricultural department distributed 7,787 coconut seedlings and 6,020 seed-nuts in 1931-32 and 4,720 seedlings and 600 seed-nuts in 1932-33.

Experimental work on coconuts was continued at Kasargod, Nileshwar and Pilicode and included a study of the several factors affecting the yield in that crop. A study of the nuts revealed that those harvested in the hot weather were larger than those harvested in other seasons and that the yield depended on the combined effects of the rains of two North-East monsoon periods and one hot weather. A study of the morphological characters and the yield in coconuts has revealed a correlation between the number of leaves and yield. Hybridization between ' tall ' and ' dwarf ' types and within selected palms has been attempted.

The cultural, spacing and manurial experiments referred to in the previous Reviews were continued in the TRAVANCORE STATE, where nearly 550,000 acres are under the coconut palm. The results of 1931-32 are not, however, strictly comparable with those of the previous years on account of the severe and prolonged drought during the year. The cultural experiments showed that where the soil was kept loose by frequent ploughing the palms were better able to stand the severe heat of summer.

Tung (Aleurites montana) has been under experiment by the BURMA Forest Department since 1929 and has not been successful, but it has been established that *Aleurites fordii*, the more valuable species, can be successfully grown in the Northern States of Burma and in some Southern Shan States. The 1929 plantations began to fruit in 1932-33 and the results were encouraging. Tung flowers in March, the fruits ripening in September. In ASSAM *A. fordii* has flowered at 18 months and is giving promising results on a number of tea estates.

African oil-palm. The BURMA Department of Agriculture has successfully demonstrated the cultivation of the African oil-palm on the farm at Mudon, and one or two pioneers are trying the crop in the districts.

9. Tea.

The area under tea in India in recent years was :—

	1930	1931	1932
Area in acres .	803,200	806,800	807,700
Production (lbs.) (black as well as green tea) .	391,081,000	394,083,000	433,669,000

Seventy-seven per cent. of this lies in Assam (in the Brahmaputra and Surma valleys) and in the two contiguous districts (Darjeeling and Jalpaiguri) of Northern Bengal. The elevated region over the Malabar coast in Southern India (including the States of Travancore, Cochin and the British districts of Malabar, Nilgiris and Coimbatore) contains 18 per cent. of the total.

The year 1931 proved more favourable for the production of tea than 1930. In spite of the abandonment of the general restriction scheme which was announced at the beginning of the year, a late start in plucking and adverse climatic conditions kept the outturn in check during the first half of the season. In the later months, however, unprecedented heavy rains following on a hot season, coupled with the late winter, resulted in an increased outturn, as will be seen above. The tea industry, however, passed through an extremely bad period during

the year owing to over-production in all tea-producing countries and excessive stocks in the world's markets. The average price per pound at the Calcutta auction sales was 6 annas 5 pies as compared with 9 annas 4 pies in 1930-31.

The year 1932 was even more favourable for the production of tea. During the early part of the year a drought was experienced in Assam but subsequent conditions proved favourable. Exceptionally favourable conditions in the Dooars and to a less extent in Sylhet contributed to an increased production estimated at 433 million pounds. The tea industry, however, passed through one of the worst years. The deepening of the world economic depression and the consequent reduced effective demand on the one hand, and the ever-increasing accumulation of stocks on the other, produced an unprecedented slump in tea prices, and the condition was aggravated by over-production in all the tea-producing countries including India. The average price of tea per pound realized at the Calcutta auction sales during 1932-33 was 5 annas 2 pies as against 6 annas 5 pies in 1931-32 and 9 annas 4 pies in 1930-31.

International agreement regarding tea control and the Indian Tea Control Act, 1933. Owing to the precarious condition of the tea industry and the consequent collapse of many concerns, an international scheme was worked out by all the principal tea-producing countries, for the restriction of the export and cultivation of tea for a period of five years beginning with 1933; the parties agreed that during this period extensions of cultivation should not be permitted beyond half per cent. of the present planted area, and not to export more than a given quantity every year, the figure to be reviewed annually. The scheme has been made applicable to India by the enactment of the Indian Tea Control Act, 1933, by which Government have undertaken to restrict exports of tea by sea to consignments covered by licenses issued by the Indian Tea Licensing Committee constituted by the Act. The scheme has given rise to new hopes in the industry which, it is hoped, will again start on a period of prosperity.

At TOCKLAI, the Scientific Department of the Indian Tea Association continued the investigation of the problems connected with the cultivation and manufacture of tea. The Chemical Branch continued its study of tannin in tea, the effect of manures on the composition and quality of the crop and on soil-acidity. It was found that the tannin content of an infusion of finished tea when allowed to stand for several days showed a steady drop, the loss being generally greatest with the tea which initially contained the greatest amount of tannin; while the tannin content of an infusion of fresh tea under similar conditions remained practically constant. The losses of tannin in tea infusions appear to be connected with the maturing of tea after manufacture. It was noticed that at least two bodies were present in the sample of tannin prepared from green leaf. In regard to the effect of manures it was found that manuring had little effect on the tannin content of the leaf, nor was the size of the plucked tea shoots much influenced by manuring. Leaf from bushes manured with varying mixtures of phosphoric acid in conjunction with a fixed quantity of nitrogen showed that the use of phosphoric acid, either with or without potash, resulted in a significant increase in the phosphoric acid content of the leaf. The use of potash in the manure increased the potash content of the leaf, as compared with that of leaf from bushes manured with nitrogen only.

The study of the factors affecting the quality of tea has yielded interesting results. A relation has been traced between the ratio of phosphoric acid to potash in the leaf and the merit of the leaf from the taster's point of view. The tea having the lowest ratio was the one placed highest in the taster's order of merit and *vice versâ*. The tea manured with phosphate and nitrogen was better than that manured with nitrogen only, and that with nitrogen and potash. The teas manured with nitrogen and potash are less preferable to the teas manured with a complete mixture, which appear to occupy an intermediate position between teas manured with the phosphatic manure and those manured with nitrogen only. Teas manured

with cattle manure were preferable to those receiving no manure and possibly a little better than those receiving artificial manures. Experiments on soil acidity are referred to in Chapter III.

The Mycological Branch continued its observations on the starch content in the roots of the tea plant in relation to crop and disease. The results obtained seem to establish a relationship between the crop produced and the starch contents of the roots and also between the amounts of nitrogen applied as manure and the starch contents. Spraying experiments with lime-sulphur solution at Tulsipara have disclosed a significant effect on the incidence of mosquito and leaf-disease in the sprayed plots. The increases of crop due to spraying amounted to 43 per cent. in 1932, and where the tea had become relatively healthy on the same plots, a further increase of 15 per cent. in crop was obtained next year. Experiments on the vegetative propagation of the tea plant were continued. The first cuttings which were planted three years ago have flowered and the bushes are equal in strength to plants of the same age raised from seed. The other investigations of this Branch included a study of the various organisms present in tea bushes, healthy as well as diseased, and experiments to ascertain the value of protective substances to pruning cuts.

The Bacteriological Branch concerned itself with problems relating to bacterial control in tea manufacture. Work was commenced on the characterisation of the tea bacteria found on leaf. It has been confirmed that the largest number occurs on the bud per unit weight of material, decreasing in numbers with increasing age of the leaves. Another fact of importance discovered was that while withering of dry leaf results in but little increase in bacterial numbers, a large increase occurred in the number of bacteria, when leaf was brought in wet owing to rain and when the surface water was allowed to remain for any length of time. If the extraneous moisture was allowed to dry off quickly, then the increase in numbers was not marked. These results have offered the much-needed explanation for the

common experience that though extended withering can often be carried out with satisfactory results at the beginning and end of the season, the same good results are not obtained during the rains and an extended wither in the rains results in dull infusions and poor liquors. Certain observations made on the amounts of tannin bodies precipitable by hydrochloric acid in tea fermented in the presence of bacteria have led to valuable results. It has been found that dark infused tea or liquors produced by bacterial infection showed a large percentage of acid-precipitable tannin, while such tea and liquor produced by stewing during firing showed a low percentage of such tannin bodies. These facts are of considerable importance in providing a method for differentiating between the two main causes of dull infusions and liquors, that is, bad firing and infection with micro-organisms. The other problems that engaged attention included a study of the development of bacteria during fermentation of leaf, the influence of temperature and other factory conditions on bacterial numbers, the correct use of disinfectants and the activity of the leaf.

The work of the Botanical Branch consisted in the examination of the rate of loss of water during withering under carefully controlled conditions and the investigation of the phenomenon known as *banjhiness* (dormancy of the shoot after several leaves have grown) and the several factors associated with it. Work is directed to ascertain and predict in advance the exact date on which a natural *banjhi** period would fall.

On the Agricultural side, trials were continued with different varieties of tea, pruning, skiffing, plucking, cultivation and manuring. An experiment in which annual pruning has been compared with biennial pruning for 13 years showed that the annual-pruned plots give higher yields. The distinct advantage of commencing pruning operations early in December has been established by experiments; where pruning was delayed until the end of March, there was loss of crop amounting to nearly 20 per cent. The cultivation experiments referred to

* *Banjhi* is the Assamese word for sterile.

in the previous Review were continued and they again indicated that the suppression of weeds is the important factor and that cultivation can be safely neglected when the land is clear of jungle.

Manurial experiments indicated that in the absence of sufficient potash and phosphoric acid the bush seems unable to utilise fully the nitrogen applied. In view of the effect of phosphoric acid on the quality of the tea crop, which has already been referred to, it is established that phosphoric acid should not be omitted from a manurial mixture for any soil, until it has definitely been shown by an accurate experiment that the soil does not require this constituent. Field experiments at Tocklai continued to indicate that tea responds fully to manuring when the mixture contains nitrogen, phosphoric acid and potash, in the ratio of 2 : 1 : 1. The lasting effect of cattle manure was compared with that of a quick-acting manure like ammonium sulphate. Four times as much nitrogen in the form of cattle manure was required to give the same effect in the first year, as with sulphate of ammonia, but while the effect of cattle manure showed little falling off during the second and third year after application, the effect of ammonium sulphate was rapidly diminishing. Experiments continued to show that the application of nitrogen, when combined with a sufficiency of phosphoric acid and potash, produces increases of crops roughly proportional to the quantities of nitrogen used. There was no significant difference when the manure was applied in one or several doses. An experiment to ascertain the relative values of organic and inorganic manures show that the cheapest artificial manure, *e.g.*, ammonium sulphate, is fully as efficient as the most expensive organic manure used. Among the latter, horn-meal and oil-cakes appear to be promising.

10. Coffee.

The coffee industry of India is confined to Southern India comprising the Madras Presidency, Coorg and the States of

Mysore, Travancore and Cochin. The total number of reporting plantations in 1931-32 was 8,191, covering a total area of 307,219 acres, as against 3,401 plantations with an area of 284,000 acres in 1930-31. The figures for these two years are not comparable, as the figures for 1931-32 include 4,413 smaller plantations of 5 to 10 acres, covering an area of 22,910 acres, the statistics for which have been included only from that year. The total area under coffee in the reporting plantations in 1931-32 was 178,224 acres, as compared with 160,261 acres, reported for plantations having an area of 10 acres and over in the preceding year. Of the total area under coffee during 1931-32, Mysore accounted for 52 per cent., Madras 24 per cent., Coorg 22 per cent., and Cochin and Travancore together 2 per cent. The total reported production of cured coffee during the year was 33,734,486 lbs. (which includes 2,470,217 lbs. reported for smaller plantations of 5-10 acres), as compared with 32,972,967 lbs. reported in the preceding year.

The total exports of coffee declined from 293,000 cwts., valued at Rs. 192 lakhs, in 1930-31 to 156,000 cwts., valued at Rs. 94½ lakhs, in 1931-32. The decrease was due to the restricted demand for Indian coffee during the year, the quality of which was reported to be rather poor, partly as a result of the heavy crop raised in the preceding season and partly on account of the unfavourable weather conditions during ripening and picking. In 1932-33, however, the exports of Indian coffee advanced to 173,000 cwts., valued at Rs. 110 lakhs, mainly on account of the United Kingdom and France, the two principal customers of Indian coffee, increasing their takings.

As in previous years, work on coffee has been centred at the MYSORE COFFEE EXPERIMENT STATION, BALEHONNUR, and the Coffee Scientific Officer of the United Planters' Association of South India worked in co-operation with the officers of the Mysore Government in connection with breeding, spraying and miscellaneous problems.

Work was continued by the Scientific Officer of the United Planters' Association on the elucidation of the life-history, the

mode of infection and distribution of the "Leaf Disease", and the phenomena of resistance to the disease shown by individual plants and strains. It seems that it should be possible to establish strains of coffee which will breed true to leaf-disease resistance. He was also engaged on a study of the relative value of different adhesives and mixtures and the time and strength of the sprays, by the leaf-count method.

Spraying experiments at Balehonnur have yielded definite and valuable information regarding the best spray mixtures to be used, the best time of spraying and means of cheapening the cost of spraying operations. The work at the Station has led to a marked increase in the area sprayed by planters and it is estimated that about 20,000 acres were sprayed in 1932-33 in the Mysore State. Double-action spray pumps which have been found to be better than two-gallon holder sprayers, are gaining ground in all estates and Rs. 35,000 worth of sprayers were supplied. The results of manurial experiments tend to show that with proper manuring the tendency for a bumper crop to be always followed by a poor crop can be largely mitigated. Among the specific manures tried, Niciphos proved best.

11. Rubber.

In 1931, the total area under rubber was 184,167 acres, which is 5 per cent. below the area of the previous year, and of this area only 91,256 acres were tapped. Of the total area under cultivation 59 per cent. was in Burma, 24 per cent. in Travancore, 7 per cent. in Madras, 5 per cent. in Cochin and 2 per cent. in Coorg and Mysore. The total production was reported to be 20,117,069 lbs., showing a decrease of 3,234,200 lbs. over that of the previous year. The exports by sea to foreign countries during 1931-32 amounted to 15·1 million lbs. as compared to 23·3 million lbs. in the preceding year. The average declared value of Indian shipments declined to 4 annas 9 pies per pound, from 8 annas 11 pies per pound in 1930-31, the total value of Indian exports falling from Rs. 130 lakhs in 1930-31 to Rs. 45 lakhs in 1931-32.

In 1932, the total area was 180,050 acres, which is 2 per cent. below the area in the previous year. Of this area only 39,481 acres were tapped. Of the total area under cultivation 61 per cent. was in Burma, 26 per cent. in Travancore, 6 per cent. in Madras, 5 per cent. in Cochin, and 2 per cent. in Coorg and Mysore. The total production was reported to be 6,381,356 lbs., the sharp fall from that of the previous year being attributed to a general slump in the rubber market. The exports of rubber from India declined from 15·1 million lbs., valued at Rs. 45 lakhs in 1931-32 to 7 million lbs. valued at nearly Rs. 9 lakhs. The price fell below all expectations, to a level (2*d*. per lb.) at which they were unremunerative.

On account of the prevailing depression of the rubber industry and the complete cessation of tapping throughout South India, the United Planters' Association of South India have felt compelled, as an alternative to closing their Rubber Research Station at Aneikulam, to work it on a bare care-and-maintenance basis. The staff of the Station has been very much curtailed.

12. Fruits.

Horticultural schemes. The Royal Commission on Agriculture emphasized the importance of research work on fruit in India especially in the selection and classification of root-stocks, in view of the potential economic value of fruit cultivation wherever marketing and transport conditions were favourable. The diversity of the soils and the climatic conditions obtaining in the several parts of India permit the cultivation of many kinds of fruits and this industry has, for some time past, shown signs of expansion owing to the rapid increase in the consumption of better classes of fruits which had hitherto been confined to a comparatively small section of the public. Moreover, it has been shown that tropical fruits, especially the mango, can find a profitable market in Europe when transported by modern methods.

The first step taken by the Imperial Council of Agricultural Research in aid of this industry was the financing of experi-

mental shipments of mangoes to England undertaken by the Bombay Department of Agriculture in 1932. These experiments clearly showed that selected Alphonso mangoes, properly packed and carried in cool storage by mail steamers, arrived in England in perfect condition and met with a good demand. Similar experiments were financed during the 1933 season also.

Funds were also provided for a co-ordinated group of schemes of work on fruit-culture in Madras, Bombay, Bengal, the United Provinces, the Punjab and Bihar and Orissa, at a cost of nearly 4·75 lakhs of rupees. A scheme of research work in Assam, with special reference to the indigenous citrus fruits, was subsequently approved. The Bombay scheme is a cold-storage research scheme, which is designed to solve a group of problems bearing upon the ' commercial storage life ' of fresh fruit, with special reference to mangoes and oranges. Fruits from Madras, the United Provinces and Bihar and Orissa are included in these experiments.

In MADRAS the Department gave increased attention to fruits during the period under review, and fruit culture was taken up on almost all the agricultural experiment stations of the province. At Coonoor a large number of peach seedlings were budded with varieties of peach and plum with a fair proportion of success. Experiments were conducted in budding the various varieties of citrus, using lemon and sweet lime-seedlings as stocks, and grafting was done by various methods and at different seasons to determine the most suitable stock to use and the best season in which to graft. The propagation of apple stocks was taken up on the lines practised at East Malling with considerable success, and a large number of stocks were raised by mounding and layering. At Burliar, mangosteens yielded the highest crop on record, *viz.*, 4,053 lbs. from 19 trees as against 1,583 lbs. the average of the previous five years.

At Anakapalle a beginning was made with a citrus orchard and observations are in progress on a number of varieties. At Samalkota, seventeen varieties and sub-varieties of plantain were under trial. The effect of restricted irrigation on this

crop was observed to be retarded flowering, a reduction in the number of ' hands ' on bunch and hastened ripening, with poorer keeping quality of the fruit.

The Systematic Botanist has undertaken an exhaustive survey of the plantain and banana varieties of the presidency, and some 300 varieties from Malabar and South Kanara have been planted at Coimbatore. A study of the vegetative and floral characters of these is in progress.

In the BOMBAY PRESIDENCY the area under fruit is increasing and is about 60,000 acres. The department's principal centre for fruit research is the Ganeshkind gardens, where varietal, cultural and manurial experiments have been laid down. Work is in progress on mangoes, guavas, grapes, bananas, *bors* and *jumbul*. The best methods of propagation are under study: in the case of the mango the budding system promises to replace the grafting system. Laboratory experiments on the preservation of fruits and fruit-juices were continued. The most interesting development during the period was the organised attempt made to explore the commercial possibilities of exporting Indian mangoes to England. A large-scale trial was conducted in the year 1931-32 with the help of a grant of Rs. 4,500 from the Imperial Council of Agricultural Research. Altogether 10 weekly consignments were sent during the mango season (23rd April to 25th June 1932), each consisting of 82 trays containing about a dozen mangoes each. The average cost of landing a mango by the sea route in London was 5 annas 6 pies and the average wholesale price realised was 8 annas 3 pies. The trials showed that, if mangoes are carefully selected, suitably packed, and stored at a low temperature, they can be shipped to London very successfully. The loss in transit was 12·65 per cent., due partly to bad handling and unsuitable storage conditions.

Another interesting development has been the successful attempt at grading of mangoes for the Bombay market. Three co-operative societies—at Malvan, Venguela and Ratnagiri—have interested themselves in the grading of mangoes, and with

the help of an expert grader lent by the department, each of these societies sent graded mangoes to the Bombay market. In 1931-32 some 10,000 parcels were despatched and although owing to the unsettled condition of the market, the prices were 50 per cent. lower than in the preceding year, substantial premia were obtained for superior grades and the advantages of grading were apparent. In 1932-33, 5,400 baskets were graded. As a result of the last three years' work the dealers are now convinced of the advantages of graded fruit, the difference between the prices of graded and ungraded lots ranging from Rs. 2 to Rs. 3 per basket in favour of the former. Small boxes are now replacing baskets for packing mangoes on a considerable scale.

The total number of fruit plants distributed to the public through departmental agency was 46,961 and 73,475 in the two years. The Taluka Development Associations are now assisting by establishing nurseries.

In the UNITED PROVINCES a grant has been made by the Imperial Council of Agricultural Research for fruit research in the hills and the experimental station will be located at Chaubattia. Fresh introductions of the department included 19 varieties of the best stocks of apples and other hill fruits from East Malling, a variety of pear stock from Egypt and vine stocks. Budding in *loquats* has been successfully carried out while similar work is in progress in mangoes and *sharifas*. Work on other fruits included attempts to improve the fruit yield of straw berries, acclimatization and trial of imported melons, attempts to increase the percentage of fruit-bearing females in *papita* and trials of peaches, plums, *santras*, *maltas*, *loquats* and other fruit trees.

A considerable amount of public interest has been aroused in the culture and marketing of fruits and a Fruit Development Board has been formed. The department continued to give assistance and advice in the planning and upkeep of gardens and practical training in horticulture was imparted to a number of students at Saharanpur and Lucknow. The department distributed to the public 16,025 fruit plants in 1931-32 and 24,276 plants in 1932-33.

In the PUNJAB, the continued fall in the price of grain has stimulated interest in fruit-growing and there was a keen demand from the public for fruit plants. Apart from a large number of plants supplied from the district orchards, the number of fruit plants, cuttings and bud-stocks distributed from the Lyallpur nursery was 3,500 in 1931-32 and over 4,000 in 1932-33.

Forty date palm trees, consisting of five varieties, imported from Basra and planted in 1910 at Lyallpur, have given very encouraging results. Hillawi, the best variety, has yielded a record crop of 3 maunds 30 seers per tree. The curing of dates received attention and an improved method has been worked out. Over 100 varieties of grapes are under trial and several have proved to be high yielders. It is proposd to try some of the better varieties on a semi-commercial scale at Gurdaspur. Over forty of the eighty-five varieties of the banana under trial at Lyallpur have fruited and a preliminary selection has been made of culinary and table varieties. Twenty-one of the thirty-three varieties of *malta* orange planted, have fruited and a careful record is maintained of the yield and other particulars of the fruit. Very encouraging results have been obtained in the preparation of grape juice and lemon and orange squashes.

In BURMA work on horticulture is carried on mainly in the garden areas of the Hmawbi, Mudon and Akyab Agricultural Stations. Of the new introductions, sapota has grown and yielded well at all the stations while litchi has not yet fruited. The Kew pine-apple has been distributed and is spreading in the vicinity of Rangoon. A collection of exotic mangoes is maintained at Hmawbi and grafts of these are now available for distribution. The necessity for improving the mango varieties of Lower Burma is very great, as good early varieties have to be imported from India at present. An increasing amount of interest is being exhibited by cultivators and gardeners and 2,874 and 7,625 fruit plants have been distributed by the department during the two years.

Experimental consignments of mangosteens to England were continued. The last consignment was made through the Indian Trade Commissioner and the fruits found a ready sale. It appears that if the fruits can be shipped in good condition, ready markets exist for this excellent fruit in the large towns of Europe. The matter is worth pursuing because the Tenasserim Division of Burma is part of a comparatively limited area of the world where the growing of this fruit is a monopoly. The chief difficulties in the way of making the export of this fruit to Europe a commercial success are: the limited area on which this fruit is at present cultivated; lack of knowledge regarding the optimum conditions of storage and the fungus diseases to which the crop is subject. It is found that the disease *Diplodia* is responsible for the largest amount of decay and that the infection takes place through the rind of the fruit. Dead twigs and young fallen fruits appear to be the main source of infection.

In BIHAR AND ORISSA, the department made a beginning in fruit culture eight years ago by introducing into Orissa various plains' fruits such as mangoes, guavas and citrus. These fruits have all now come into bearing and the quality of the crop has been found to be satisfactory. At the Angul Farm mangoes and oranges gave an excellent crop, and Mosambi oranges, rose-apples, lemons, guavas, plantain and papaya have done very well under Cuttack conditions. The departmental nurseries issued 1,941 and 3,313 fruit plants during 1931-32 and 1932-33, respectively.

In ASSAM the orchards at the Khanapara, Haflong and Shillong Farms continued to be maintained and 1,111 and 3,545 fruit plants were supplied to the public in the two years under review.

In SIND, since the advent of perennial irrigation, there has been a most noticeable increase in public interest in fruit culture and the work at the Government Fruit Farm, Mirpurkhas, has been considerably intensified. Experimental work includes the cultivation of " cover-crops " in orchards, determination of the

optimum distribution of irrigation water to fruit trees, the best seasons for budding and grafting under Sind conditions, trellising with different varieties of grapes, the technique of pruning and training for yield and the regrafting of mango varieties from the United Provinces, Bihar and South India on local stocks adapted to Sind conditions. Of the citrus varieties maintained at the Farm, the Nagpur *santra*, Jamaica, *malta* and Mosambi oranges are suitable for the Barrage areas. Experiments are in progress with different stocks for *santra* oranges. The number of fruit plants distributed by the department during the two years under review was 3,485 and 7,943.

In the NORTH-WEST FRONTIER PROVINCE the total area under fruit is 14,872 acres, of which 12,937 acres are in Peshawar District. The Tarnab Farm, which is responsible for the large number of nurseries in Peshawar District, continued to help the fruit-growers by supplying a large number of young peach, plum and apricot plants at cheap prices every year and by supplying skilled gardeners to the neighbourhood. The new plantations during the period include ten varieties of *malta*, 400 plants of Thomson Improved Washington Navel *malta*, six varieties of grapes, a number of South African importations of peaches, plums, almonds, cherry, apples, pears and quinces and of French red apricot. Attention is being paid to proper manuring, pruning and spraying.

In BALUCHISTAN, the Fruit Farm at Quetta continued to be maintained and a number of fresh plantings were made during the period, including several varieties of apples, pears, peaches, nectrines, cherries, grapes and figs. Several stocks of fruit trees have been obtained from East Malling for vegetative propagation by stooling and layering methods. A number of inferior varieties of pears and apples have been top-grafted with superior scions. A preliminary survey of the insect pests of the province has been carried out and spraying demonstrations on an extensive scale were conducted for the first time in the province and 18,000 fruit trees were sprayed in 15 villages.

13. Fodder Crops and Grasses.

The Physiological Chemist, Bangalore, is continuing his investigation on Indian fodders. Various Indian coarse fodders are being tested for digestibility: feeding experiments with *juar* stalks in the prime stage as they come in from the field and with identical material converted into hay have shown that conversion into hay leads to a notable increase in the crude fibre fraction and a corresponding serious lowering of digestibility of the carbohydrates. Experiments have also been undertaken to elucidate whether marked physical differences exist between the carbohydrates of such distinct products as rice straw, *ragi* (*E. coracana*) straw, sorghum and hay, which possess distinct different digestibility coefficients. In view of the desirability of encouraging the production and utilisation of leguminous hays, an investigation into the best method of preparing them, their digestibility and their effect on the nitrogen-balance has been undertaken.

The effect of supplementing a fodder ration with a mineral is being tested both with growing animals and adult bullocks. In the case of the former it has been noticed that 0·47 per cent. lime and 0·73 per cent. phosphoric acid in the basal ration suffice for normal growth. In the latter case the fodders used were rice straw and sorghum hay, and the mineral calcium phosphate which at one stage was also supplemented by green food. Determinations of mineral balance have indicated that rice straw provides just enough phosphoric acid but not enough lime, while in sorghum hay there is a sufficiency of both lime and phosphoric acid. The results of both experiments have emphasized that a mineral supplement has no effect in cases where sufficient is present in the fodders themselves.

The object of another investigation is to determine the comparative feeding values and the mineral composition of grasses grown on selected typical soils in various parts of India. It has been observed that the protein content is a specific character and that the mineral content varies with the stage of maturity, the dead ripe stage being associated with very poor quality.

Experiments undertaken on the PUSA Farm to arrive at the best method of preserving berseem in silo pits have shown that there is least wastage when berseem and oats straw are placed in alternate layers in the proportion of 3 :1 by volume, that green oats if available can also be used in place of oats straw, and that the March and April cuts of berseem, being less watery, are most suitable for ensilage.

In MADRAS a comparative study is being made of the indigenous fodder grasses suited to South Indian pastures at the Central Farm, Coimbatore. *Andropogon annulatus*, *Pennisetum cenchroides* and *Iseilema laxum* have hitherto given the best yields under irrigation. Teosinte (*Euchlaena mexicana*) was tried at Coimbatore, Hosur and Aduturai. It came up well at the first two places, and yielded 32,000 lbs. per acre at Coimbatore. *Pillipesara* (*Phaseolus trilobus*) is extending rapidly in the Godavary delta, where an area of 5,675 acres is grown with this fodder. It is being introduced into the other circles also. It was tried at Aduturai, where it gave 22,600 lbs. of green fodder per acre in two cuttings and gained popularity among the ryots. The fodder problem in the West Coast is a peculiar one. Plenty of hill grass is available just after the monsoon in May and June, but by November or December the grass gets dried up and nothing is left for the cattle. The department is advocating the preparation of silage and hay from the hill grass. At Taliparamba two silo pits were filled with sorghum, cow-gram and hill grass. The silage obtained was quite good and supplied succulent fodder in the hot months of March and June.

At the cattle-breeding farms at Chharodi and Bankapur in BOMBAY several fodders and their relative values are being determined. At Bankapur the pulse (*kulthi*) *Dolichos biflorus* has been found to be a good nutritious fodder in addition to serving as a valuable rotation crop. Among the other fodders which were successful at these stations may be mentioned *juar*, *kharif* maize, *bajri*, berseem and soybean. Six varieties of soybean have been tried with success and seed of these is being

distributed throughout the Presidency. Work is in progress at Chharodi on the collection, identification and chemical analysis of wild leguminous flora in the pastures.

The work of the Economic Botanist on the improvement of grazing lands has been embodied in a bulletin which gives a comprehensive survey of the problem and describes the method in detail. Large-scale experiments have been laid down in various parts of the Presidency. The advantages of the rotational system of grazing and bunding of grazing lands are evident at all the places.

Of the several fodder grasses tried in BENGAL, Napier grass has definitely proved to be the heaviest yielder. With proper manuring and irrigation this grass yielded on the Dacca Farm at the rate of 1,482 maunds per acre. About 80,000 cuttings have been distributed. Three types of fodder *juar* have been selected: early saccharine, early non-saccharine and medium late. These are being multiplied for seed. Among the leguminous fodders tried, the most promising is the American cow-pea which yields good crops at a time when there is scarcity of green stuff. A number of other fodders are under trial. Good silage has been made from *juar* and *aus* paddy straw and also from water-hyacinth and paddy straw.

The main fodder crops grown at the Madhurikund and Manjhra Cattle Breeding Farms in the UNITED PROVINCES are *juar* and *guar*, usually mixed, of which large amounts are produced and the major part converted into silage. At the Madhurikund Farm, berseem and lucerne showed luxuriant growth due to previous inoculation of the soil with bacterial cultures. Elephant grass did well and produced good growth.

The Fodder Specialist in the PUNJAB continued a study of the comparative yields of Sudan grass and cow-peas grown alone and mixed together. A mixture of the two gave the highest yield and also provided a nutritious fodder. Another mixture which proved to be the best of the various combinations tried was one containing cow-peas and Imphee-*juar*. In all the trials cow-pea has proved to be a valuable fodder, in that it

grows well under drought conditions when the other fodders would not flourish. A selected strain which is also drought-resistant has proved superior as regards leafiness and yield. This is of great value under *barani* conditions. Sudan grass has also been found to be a good yielder and fairly drought-resistant. It tillers so profusely that it shades the soil and prevents loss of moisture; in addition, it supplies green fodder in May when there is general scarcity of fodder. Arrangement has been made to produce sufficient seed for distribution. Elephant grass has become very popular as a heavy yielder of green fodder throughout the year. Its chief merit is absence of mortality when once established. Unfortunately it does not set seed under Punjab conditions. Among the pasture grasses tried, *khawi* (*Andropogon Iwarancusa*) was the only one which could be grown without irrigation for any length of time, the reason for this being that it has a fairly deep root-system. A promising selection of velvet bean has been found to give a high yield of palatable leguminous fodder at a time when neither *kharif* nor *rabi* fodders would be available for the cattle. Berseem has established itself as a popular *rabi* fodder, and the practice of growing it after rice is gaining favour as this assures a supply of good green fodder in winter. Among the various imported varieties of oats tried, French oats appeared superior as green fodder, though in common with other exotic varieties it did not mature seed.

A plot of about two acres in the Kahuta hills has been selected for observations on pasture. A census of plant population has been made and a study of economic characters is in progress. The fodder problem is an important one in the Kangra valley where no land can be spared for fodder cultivation.

Berseem was grown on all the major farms in BIHAR AND ORISSA. It has been definitely established that a heavy crop of berseem can be obtained on the Chota Nagpur Plateau. Another important discovery was that the crop sets seed at the Kanke Farm, which can therefore grow its own seed require-

ments. Elephant grass has proved its value throughout the Province and is yielding heavy crops. There is demand for seed from the cultivators. A valuable method of making silage from maize stalks has been worked out and excellent fodder has been prepared by this method. The scientific details remain to be worked out. Lucerne was successfully grown at Sabour and the crop kept itself for three years continuously without deterioration. Seed has been supplied to other ranges. In a comparative yield trial of the broom-corn with the ordinary local *juar* and the Manchurian *juar*, broom-corn has established its undisputed superiority over the two *juars*. Its yielding capacity coupled with quick growth and palatability makes it a desirable fodder crop.

With a view to trying on a large scale the Economic Botanist's method of improvement of pasture by ' re-seeding ' and ' rotational grazing ', experiments have been laid down at the Telinkheri Farm in the CENTRAL PROVINCES. Two types of herbages have been selected, one containing chiefly *Andropogon pumilus* and the other an area seeded with better strains of grass such as *Ischaemum sulcatum* and *Ischaemum laxum*. The seeded area yielded fifty per cent. more dry grass than the local pasture, although it appears that the actual amount of calcium and phosphoric acid removed from the soil is more or less the same in both the cases.

Annual fodder crops such as maize, *juar*, etc., have not been found suitable to ASSAM conditions; on the other hand, perennial grasses of tall growth, notably Guinea grass and Elephant grass, have been found economical. Rhodes grass and *pava* grass are under trial at Khanapara; the latter which has been obtained from Ceylon is very promising.

In SIND, berseem is grown at the Agricultural Research Station, Sakrand, where it is utilized for *rabi* cropping in the rotational systems designed for the reclamation of *kalar* lands. The crop is fed to cattle *in situ* or cut as green fodder, small plots being reserved for seed production. Efforts are being made to increase the production of seed, as the high cost of

seed is a handicap to the extension of this fodder crop. Berseem is also sown in rotation with cotton. Soybeans grown for fodder yielded 19,000 lbs. of green fodder in the first cutting taken two months after sowing.

The area under berseem in the NORTH-WEST FRONTIER PROVINCE is on the increase and there is a keen demand for seed from other provinces. This crop is gradually replacing *shaftal* in the Peshawar, Bannu and Hazara Districts.

14. Millets.

The principal millets cultivated in India are *juar* (*Andropogon Sorghum*), *bajra* (*Pennisetum typhoideum*) and *ragi* (*Eleusine coracana*).

Juar. This crop occupies about 33·5 million acres in India, and the important *juar*-growing provinces and states are Hyderabad (9·5 million acres), Bombay (including Sind) (8 million acres), Madras (4 million acres), Central Provinces and Berar (4·5 million acres), United Provinces (2·5 million acres) and Punjab (1 million acres).

The Millets Specialist in MADRAS continued his study of this crop (local name *cholam*) both from the economic and scientific aspects, at the Millet Breeding Station, Coimbatore, and the Agricultural Stations at Hagari and Nandyal. A yellow strain of *juar* (A 5809) and a white strain (A 5175) have proved promising for a second time, and are being tested under ryots' conditions. Comparative trials of strains suitable for the summer and mixtures of strains suitable for the main season are in progress. The Periamanjal strain No. A558 has been found to be the best of its kind. As a fodder *cholam*, a dull, mid-ribbed variety has been found superior but it does not set seed at Coimbatore. A cross between this and local Periamanjal is under trial. Work on the inheritance of characters and the floral characteristics was contained.

A number of cultural improvements have been tried. Ploughing gave better results than harrowing. In a spacing trial at Hagari with wider spacings of 27 in. and 15 in. than the

normal 13½ in., 15 in. spacing gave a higher yield of fodder and 27 in. spacing a bolder grain. At Nandyal, applications of artificials increased the yield of the first sorghum crop and the residual effect of the application lasted for two subsequent crops of cotton and sorghum. Six thousand four hundred and 10,928 lbs. of T. 1 and T. 6 sorghum seed were distributed to ryots in the sorghum-growing tracts.

Juar-breeding is in progress at various centres in the BOMBAY PRESIDENCY. The most valuable results have been obtained at Mohol in East Deccan, with a variety of *rabi juar* called Maldani, which occupies 1½ million acres. It has been found that this variety is a mixture of two types, one with a long internode and the other with a short internode. The former grows and reaches maturity a fortnight earlier and consequently is a valuable type for tracts of precarious rainfall. Four selections have been made from this type which give higher yields than the unselected Maldani. Work is also in progress on two other varieties, Dagadi and Tambada-Gota. An improved strain of Gujrat *juar* called Budh Perio No. 53 has been isolated by the department and is being widely distributed.

The two important improvements which have been introduced by the department for this crop are an improved method of dry-farming cultivation and seed-grading. The former method includes five important items—deep ploughing, small bunds, broad sowing, graded and dusted seed and interculturing. Increases in yield ranging from 20 to 25 per cent. have been attained by this combination of improvements. Seed-grading has become a permanent feature in the East Deccan, and with the help of non-official agencies 440,000 and 430,000 lbs. of *juar* seed were graded during the two years under review. The increased yield due to seed-grading is 10 to 15 per cent.

Of the several varieties of *juar* under trial in the UNITED PROVINCES, No. 5 appears to suit Bundelkhand and 8A and 8B for the Western districts.

Mass selection in the PUNJAB has produced a sweet type of *juar* which, in addition to being a good yielder of grain, produces fodder of high food value.

In the CENTRAL PROVINCES two yellow-grained *juars* known as improved Saoner 123A and E31 have been found promising and are being distributed for multiplication.

An American *juar* known as Honey Sorghum has been found in SIND to be definitely superior to local fodder varieties: it produces fodder much relished by cattle though the yield of grain is low. Three new selections of grain *juar* have given as good yield as the improved Sind variety Saoro Kurtho No. 1 and they are under trial. In Dadu District the improved variety Bagdar No. 1 has given good yields. Other improvements tried are trials with late maturing *juars* to avoid long smut which attacks early types, grading, and control of smut by sulphur dusting.

***Ragi* (*Eleusine coracana*)** is grown on an area of 6·6 million acres, of which Mysore and Madras account for 2 million acres each, and Bombay and Bihar and Orissa have most of the remainder.

In MADRAS, this crop has been studied in detail at Coimbatore and also at Anakapalle. A short-duration variety called E. C. 593 isolated at Coimbatore has been found to out-yield the local varieties by 15 per cent., while E. C. 47 is finding favour in parts of Coimbatore District as a late type. Four selections made at Anakapalle are of promise.

In BOMBAY, four superior strains—A16, B11, E31 and E82—have been distributed to registered seed-growers in the Konkan and the area under them is about 1,235 acres.

In MYSORE STATE, in addition to the strains H22 and H2 previously introduced, four new selections of dry land *ragi* and one of irrigated *ragi* have been found promising for the Hain *ragi* tract. Five promising strains have also been evolved at the Hunsur Kar Ragi Breeding Station.

Bajra. This crop occupies about 17 million acres, of which about 5 million are in Bombay, over 3 million in the Punjab and

about 2 million acres each in the United Provinces and Hyderabad.

The variety called Akola *bajra* is being distributed to cultivators in the BOMBAY PRESIDENCY and now occupies 6,107 acres. The breeding work on this crop which was carried on by the Economic Botanist is continued by the Cereal Botanist at Niphad which is situated in the heart of the *bajra*-growing tract. The Economic Botanist is also continuing his trials on the selfed seed of the three varieties isolated by him.

Mass selection in the CENTRAL PROVINCES has provided a considerable proportion of large-sized heads. Four of these selections are reported to be promising. Two of the previous selections have replaced local *bajra* on the Akola Farm. Two improved selections have done well both under *barani* and irrigated conditions in the PUNJAB.

15. Other Cereals.

Barley. Of the six-and-a-half million acres under this crop in India, 4 million acres are in the United Provinces, $1\frac{1}{2}$ million in Bihar and Orissa and 650,000 in the Punjab. In 1932-33 the total yield was estimated at 2,351,000 tons.

In view of the preference of 10 per cent. accorded to Indian barley in the United Kingdom, there are prospects of re-establishing the export in malting barley, and increased attention is being given by the departments in India to the evolution of types suitable for the export trade.

The improved Type 21 evolved by the Imperial Economic Botanist at PUSA continued to maintain its reputation. In a yield trial with Type 21 and the Cawnpore Type 251, the former gave a significant increase of 10 per cent. over the latter. Type 21 is not, however, quite suitable for malting and brewing purposes, because of the purplish colour of the grain. Some hybrids, combining high-yielding capacity and white colour, appear promising. *Helminthosporium* attack on barely has been severe in late years. For this disease, treatment with uspulun has been found to be more efficacious as a control measure than treatment with formalin.

The variety of barley called C. 251 evolved by the Assistant Economic Botanist, UNITED PROVINCES, though not so high an yielder as the Pusa types, possesses the advantage of being eminently suitable for brewing. A consignment of this variety was sent to the United Kingdom for brewing tests and has been reported on as the best Indian barley that the firm had handled.

The Rewari Type No. 4 and the Lyallpur Type No. 5 have definitely established their superiority over the other types selected in the PUNJAB. Samples of these types were sent to the Imperial Institute for report on their malting and brewing capacities, and favourable reports have been received on Type No. 4. A scheme for sending large samples to the Institute of Brewing for testing as regards malting and brewing qualities has been sanctioned by the Advisory Board of the Imperial Council of Agricultural Research. It has been found that when *rabi* sowing is delayed as late as December it is more profitable to sow Type No. 4 barley than even improved wheats. Large amounts of this type are being purchased every year by a Calcutta firm for the manufacture of 'pearl' and 'powder' barley products.

Maize. Of the seven million acres under maize in India, the United Provinces accounts for two million, Bihar and Orissa for 1½ million and the Punjab one million. The total yield was estimated at 2,144,000 tons in 1932-33.

At Sabour in BIHAR AND ORISSA a local Tinpakhia variety having given better yields than Italian Pioneer, mass selection therefrom has been undertaken. In the UNITED PROVINCES Jaunpore maize continues to be popular.

Peshawar White is the popular variety in the NORTH-WEST FRONTIER PROVINCE. It is early-maturing and gives a white and sweet bread. An American variety known as Iowa Silver Mine appears to suit Upper Hazara conditions and is spreading in that area.

Oats. The hybrid oats evolved at PUSA have been subjected to comparative yield trials at Pusa and Karnal. At Pusa where the crop did not receive any irrigation and the year was un-

usually dry, the hybrids gave better yields than the B. S. selections. At Karnal, however, where the crop was grown under irrigation, the hybrids maintained their superiority over the B. S. selections, and confirmed the results usually obtained at Pusa in years of normal rainfall. Among the hybrids, Types C and J have promised well and in addition to possessing a plump grain and good tillering, they yield a high quantity of straw. Eighteen thousand and seventy-four lbs. and 7,826 lbs. of oats seed were distributed from Pusa and Karnal in 1931-32 and 1932-33. The results of recent work at Pusa on this crop are contained in two papers recently published.

16. Potatoes.

At the time of writing this report a fresh impetus has been given to research on potato improvement by the results of various scientific expeditions to South America and by the recent work in the U. S. S. R.

All the potatoes in general cultivation outside South America appear to have been derived from a few varieties which were introduced into Europe in the sixteenth century. The number of varieties was increased by selection from seedlings and by crossing, but with such poverty of initial breeding material it is perhaps surprising that so much progress has been made. The problems of blight (*Phytophthora infestans*), virus disease, etc., remain unsolved and, in fact, a *cul de sac* was reached. But with the discovery by the Russian Expedition to South America—and the succeeding American and German Expeditions—of a large number of both wild and cultivated species, some of them possessing characters exceedingly valuable from the breeding view-point, the outlook has changed entirely and it is now possible to take a more hopeful view of the future of potato-growing.

In India the problem is peculiarly complicated. In the plains during the hot weather the grower often loses the greater part of his stock owing to rotting caused by various fungi and bacteria; no really satisfactory method of storage, which is at

the same time commercially practicable, has yet been evolved. An even more serious difficulty is that after two or three seasons in the plains potato varieties appear to ' degenerate '—doubtless largely due to the virus diseases which are so common in the potato—and the cultivator has to obtain a fresh seed-supply from the hills, paying heavy freight on this. In the hills the crop is liable to blight from which the crop in the plains is fortunately generally free. Again, in those districts where two crops in the year are taken the tubers from the crop cannot be used as seed for the other, unless there is an interval of about two months, as the potato tuber exhibits dormancy.

It will be clear from the above that there are many difficulties to be surmounted in effecting potato improvement in India. Recently, a comprehensive scheme of research and breeding at Pusa and at a sub-station in the hills, with the aid of a grant from the Imperial Council of Agricultural Research, has been drawn up. This embraces: (1) the study and classification of the varieties usually grown in India; (2) the procuring of South American potato material and the crossing of this with the best Indian varieties in order to produce new varieties possessing desirable qualities, especially immunity or high resistance to blight and resistance to virus diseases; (3) the study of the factors influencing flowering and fruit development; since it is well known that fruit formation and seed-setting in the potato is usually poor, a knowledge of this and allied problems is necessary for successful hybridization; (4) an investigation of the possibility of breaking dormancy in the tuber by simple chemical or mechanical treatments.

In MADRAS, potato is an important crop on the Nilgiris where it occupies about 10,000 acres. There are three seasons, the main crop from April to August with a cultivated area of about 7,000 acres, the second crop between September-January with an area of 8,000 acres, and a small crop early in the year under irrigation. Experimental work on this crop is centred at the Agricultural Research Station, Nanjanad, where the yields for the main crop were nine-fold in 1932-33—the highest

obtained ever since the opening of the station—as compared with six-fold in the previous year. The second crop yielded four-fold. In the season of 1932-33, the crop on the Nilgiris was badly diseased, but the crop on the Station was free from disease. Experiments are in progress on different manures, size, spacing, planting cut and whole setts, comparison of new seed with old seed, and spraying against *alternaria*. Manurial trials have shown that the present application of concentrates consisting of superphosphate, sulphate of ammonia, bone-meal and sulphate of potash, in addition to groundnut cake, is suitable. A number of cereal crops are being tried in rotation with potatoes. The seed-supply in 1931-32 amounted to 2,037 maunds, of which 37 maunds were distributed in the plains in the Salem District where it yielded 10 to 15 per cent. higher than the local product. In 1932-33, 1,668 maunds were distributed of which 980 maunds were issued under seed farm conditions. The seed from Nanjanad is reported to have practically replaced the local seed on the Nilgiris.

In BENGAL storage experiments with the white local variety showed that this variety can best be preserved in a cool, ventilated house, without any special treatment.

In the UNITED PROVINCES this crop had received special attention hitherto at the Farrukhabad Farm which, however, was closed down during a period of retrenchment. As a result of a series of trials with a number of improved types, two have been finally isolated which promise to be effective yielders and of much higher quality than the local crop. The potato-moth and mosaic disease are the two limiting factors in the extension of this crop. The former tends to the destruction of tubers during storage and the latter leads to the deterioration of the size of the tubers of such seed as survive the inroads of the former. Simple means of largely reducing the ravages of potato-moth have been evolved. In regard to mosaic, the two selected strains referred to are also resistant to the disease. In order to overcome the difficulties of storage in the plains during the summer and the rains, steps are being taken to organise a

seed-growing organization in the Kumaun hills. A high-level growing centre on the hills has been arranged for the testing out of imported varieties from overseas and elsewhere in India. The seed so secured will pass to a lower lever station, where they will be sown in February, harvested in July, stored at a high level and passed down to the plains for sowing in October. By these means it is hoped that a steady flow of good seed will reach the plains every year. A ' ring disease ' appeared in a serious form in some parts of Nainital District. It has been found that the disease is transmitted through infected soil and seed tubers. Long rotation and careful selection have been recommended as preventive measures.

In the PUNJAB, the improved Scotch varieties have continued to yield well on the Simla hills, the net gain to the cultivators by the use of these varieties amounting to Rs. 100 to Rs. 120 per acre over that obtained with the local seed. Most of the potato experiments have been concentrated in the Kangra valley with a view to making that place a source of seed-supply for the autumn-sown crop in the plains of the Punjab. The present indications are that the produce harvested in the hills in June could be stored there without serious loss and utilised as seed-supply for the plains.

In BIHAR AND ORISSA potato is an important crop in South Bihar and large quantities are annually exported to Central India and the Punjab, the seed being brought down from the Darjeeling hills. Field-scale trials were made at Patna of growing the crop in the plains from seed grown during the monsoon on the Chota Nagpur Plateau, but due to a severe outbreak of disease the results were unreliable.

In the CENTRAL PROVINCES the method of storage in underground pits during summer, which has been worked out by the Mycologist, was demonstrated at Tamia in the Chindwara District. The cost of storage is only $4\frac{1}{2}$ annas per maund which is practically negligible since the materials can be used for more than one season. Experiments are in progress to find suitable method of seed-storage during the rains to provide seed for the

rabi sowing. As a result of the department's demonstration at Tamia, there has been a great increase in the demand for good potato seed, applications for over 800 maunds of seed having been received from one *tahsil* alone. The extension of this crop in the plateau area where it can be grown successfully would give the cultivator a good money crop.

At the Upper Shillong Farm in ASSAM, Talisman, Factor, Bishop and Kerr's Pink completed their third year under trial and proved satisfactory. Three new varieties were imported in 1932, *viz.*, Great-Scott, Majestic and Arran Banner, and included in the trials. Among the varieties that gave the best outturns in 1932-33 were Ben Cruachen, Perth Favourite and Windsor Castle. The improved Darjeeling varieties proved better than the Shillong varieties in the demonstrations. Selection work with a view to evolve blight-resistant types is in progress. Experiments with treatment of seed with chemicals for storage were unsuccessful and have been abandoned. Storing in moderate light with free passage of air was fairly successful. Manurial experiments with various chemical fertilizers have been laid down. The amount of potato seed sold to the public was 784 maunds and 1,700 maunds in the two years. The total under improved varieties is now 14,226 acres.

At PUSA experiments on potato storage showed that potatoes harvested a fortnight or three weeks earlier than the usual time (beginning of March) keep better. Cinders and charcoal proved the best storage materials as before. Experiments are in progress to determine the effect of previous manuring on the keeping quality of the crop.

17. Beans and Pulses.

Gram. This crop occupied 14,699,000 acres in 1932-33 and the total yield was estimated at 3,469,000 tons. The recorded area under improved types is 248,035 acres, of which 146,809 acres were in Burma and 99,000 acres in the United Provinces.

All the eighty-four distinct types previously isolated at PUSA were maintained in pure culture. A preliminary varietal trial

with two new types, Types 51 and 58, and an old established type (Type 17) was carried out, and the results showed a decisive superiority in the yielding power of Type 58 over Type 17. The hybridisation work with gram was continued at Karnal and a study of the inheritance of characters has been made. A cytological investigation of the giant mutation has been carried out and the results published.

On the average of the last three years there are 5,396,000 acres under gram in the UNITED PROVINCES and the estimated area under improved types is 99,000 acres. The seed-supply consisting mainly of Pusa types amounted to 11,242 maunds in 1931-32 and 13,364 maunds in 1932-33. Some hybridization work is in progress and the crosses are in the second and third generations.

The PUNJAB has on the average 4,521,000 acres under gram and is the second gram-growing province. Pure types which have been isolated are under trial in various parts of the province. Punjab Type 7 has done well in the south-west of the province, but Punjab Type 17 gave a better yield in some other localities. At Hansi, the local mixture gave higher outturns than the pure types. The investigation of gram blight has yielded interesting results and the knowledge gained has enabled preventive measures to be devised. The important conclusions are:—(1) that the fungus which causes the disease is carried over from year to year on the diseased plants, in the gram fields and on threshing floors, and also in the seed but not in the soil; and (2) that the attack is considerably reduced when gram is sown mixed with wheat and barley. To encourage cultivators to adopt preventive measures, the Local Government gave a notice that suspensions or remissions of revenue would not be granted in the coming year on account of the destruction of the crop by this disease unless the cultivators had sown pure, uninfected seed supplied by the department, had sown the crop intermixed with barley or wheat, and had uprooted the diseased crop by hand or, if harvested, had burnt it together with all roughages from the threshing floors.

Gram occupies on an average 1,465,000 acres in BIHAR AND ORISSA. The area under improved varieties was 2,226 acres, the varieties under distribution being Sabour 4, Sabour 2 and Pusa 17. Studies on gram hybrids were continued and some of the hybrids are promising in yield, boldness and colour.

In the CENTRAL PROVINCES the average area under gram is 1,341,000 acres. The isolation of unit species in this crop has been nearly completed. With a view to obtain a wilt-resisting, high-yielding type, the best local selection No. 28 has been crossed with a wilt-resistant Cawnpore type, and the crosses are under trial. Ten selected cultures are being tested for yield at the Powarkhera and Adhartal Farms. Trials have confirmed the superiority of Cawnpore and Karachi grams in their power to resist wilt.

BURMA has about 187,000 acres under gram on an average, of which 146,809 acres are now under improved types, Karachi gram being the popular variety. Seed issues amounted to 132,206 and 106,899 lbs. in the two years. The rumour that the Karachi gram was subject to wilt disease proved to be groundless. Breeding work on this crop is in progress.

Pigeon-pea. At PUSA the isolation of the pure types of this pulse was finished and a paper on the subject published in the *Indian Journal of Agricultural Science.* There are 86 distinct types varying in a number of characters. With regard to plant-habit there are two main classes, erect and spreading. The erect types are generally preferred because they allow interculture to be done easily and do not interfere with the growth of maize which is usually grown mixed with this crop in North Bihar. A case of bud variation occurred in a single individual type and is under study.

The promising types of this pulse were subjected to yield trials on the Pusa Farm and Types 24 and 51 gave the best results. The latter type also possesses erect habit and wilt-resistance.

The work on resistance to wilt disease was continued in collaboration with the Imperial Mycologist, and a Monograph

has been published. There are now six wilt-resistant types available, and it is now established that there is no definite correlation between wilt-resistance in *arhar* and its morphological characters. The mode of inheritance of the wilt-resisting quality is under investigation.

In the CENTRAL PROVINCES an improved strain No. 3 is being multiplied for distribution. A study of the inheritance of certain characters having been completed, work on the production of wilt-resistant types has been started.

In yield trials with erect varieties in BIHAR AND ORISSA, the Sabour selection 2E gave significantly better results than any of the Pusa types. Among the spreading types Pusa 8 and Sabour 7S were better than the other types.

In BURMA a departmental selection of this pulse (locally known as *pèsinngon*) has found favour with the cultivators, and now occupies 2,100 acres.

In BENGAL work has been mainly confined to the selection of heavy-yielding strains of Comilla *arhar*, which is an early type with a large bold grain. The departmental selection of Comilla *arhar* gives a much higher yield than the local early types. A later type known as *chaiti* is more prolific than the Comilla selection but not so tasteful. Work has been started at Bankura with the object of producing an early, prolific type of *arhar* for the Western Bengal districts.

Peas. At PUSA the tentative classification of types made last year was checked and progress was made with the isolation of pure types. *Sativum* No. 14-1 is a dwarf garden pea with large wrinkled seeds, which has given good yields when grown without sticks: this will be multiplied for distribution.

Lentils (Ervum lens). The study of the inheritance of flower and seed-colour was continued at PUSA and some very promising forms with bold seed have been evolved which are under trial. In this crop the bold-seeded varieties usually give poor returns and this proved to be the case in a trial carried out on the Pusa Farm. In BENGAL twelve types have been selected on the basis of yield and the period of ripening.

Urid and mung (Phaseolus mungo and P. radiatus). Twenty-five types of *urid* and 40 types of *mung* have finally been selected and classified at PUSA and two papers embodying these results have been published. A study of the root-system of these two pulses was made and an attempt will be made to correlate some important characters with the root-system. *Mung*, grown in July at Pusa, gave good growth of foliage, but all the types tried failed to set a normal amount of seed.

An experiment on the effect of time of sowing on the yielding capacity of *mung* and *kalai* was conducted in BIHAR AND ORISSA. The year's results showed that in the case of *kalai* fields sown on the 25th of August gave the best outturn. The experiment will be repeated.

Twenty distinct types of *kalai* (*Phaseolus mungo*) isolated at DACCA in Bengal in previous years underwent preliminary yield tests. All the pure strains appeared to be better yielders and one of them showed distinct promise.

Beans. In BURMA the interest in pulses centres mainly on the new type of bean which was introduced from Egypt seven years ago and which the Burma Chamber of Commerce decided to call the Burma Butter Bean. This bean has been shown to consist of two distinct types, of which the superior one, ' Moki Lima ', which is the type that is favoured by trade, has been multiplied for distribution. The ' Moki Lima ' has however been found to be not quite suitable for the poorer soils of the dry zone and the Economic Botanist is engaged on the production of types by selection and hybridization, which while satisfying the demands of the trade can be cultivated in all classes of soils. A number of pure cultures of this bean are under trial, and tests are also in progress with seven other varieties of *Phaseolus lunatus*, of which the large Madagascar bean is one that has been found promising. The inheritance of seed-coat colour in *Phaseolus lunatus* has been worked out and the results published in the *Indian Journal of Agricultural Science.*

Trial shipments of the Burma Butter Bean were sent to England in both years. In 1931-32, on account of general slump

in prices, the bean was valued at £9 per ton as against £6-7 for the Rangoon white bean. In 1932-33 the consignment fetched an average price of £11 per ton, when the Rangoon white bean was selling at £7-10. It has been decided, on the advice of the Indian Trade Commissioner, not to send further trial consignments, but to allow the bean to take its chance in the ordinary course of trade.

The recorded area under the improved varieties of this pulse was 9,059 acres in 1932-33 as compared to 3,153 acres in 1931-32 and 407 acres in 1930-31.

CHAPTER III.

RESEARCH IN CROP PRODUCTION.

I.—Soils and Fertilisers.

During the period under review, research and investigation in agricultural chemistry was mainly on lines similar to those followed in previous years. In addition to the investigation of problems of local interest, general studies on the chemical, physical and biological properties of soils were carried out. These several activities are described in the briefest manner possible and for fuller information reference is invited to the annual reports of the Imperial Institute of Agricultural Research and of the agricultural departments in the Provinces and Indian States.

(*a*) ***Soil-surveys.*** Soil-survey programmes with reference to fertiliser requirements and crop zones were continued in several provinces. Special surveys to determine the suitability of particular soils for irrigation and drainage, or to ascertain the effect of irrigation on certain soils, were in progress in MADRAS, MYSORE, HYDERABAD, BOMBAY and the PUNJAB.

(*b*) ***Mechanical analysis of soils.*** Considerable attention continues to be paid to the textural classification of soils based on mechanical analysis or the other physical characteristics of the soil. A comparative study of several methods for mechanical analysis of soils was continued in BENGAL. On soils rich in carbonates, the Puri's method and the Electro-filtration method were found to give slightly lower figures for clay than the International method. With heavy soils the International method gave lower results for clay than Puri's method. Electro-filtration failed on the salt soils of Ramiguchi. The clay fractions obtained by the Puri and Electro-filtration methods contained some humus. On the other hand, in the laboratories of the Dacca University identical clay and silt values were obtained for laterite soils whether the International, Sudan or Pusa method was followed or the soil shaken with sodium hydroxide

without pre-treatment with hydrochloric acid or sodium chloride.

At LAHORE, two pieces of apparatus suitable for estimating the size distribution curve of soil particles have been devised. One is a type of hydrometer. The other is a differential liquid manometer which balances a benzene-aniline mixture against water. By connecting this to two tubes which dip into water and soil suspension respectively, changes in the density of the soil suspension are conveniently read off.

At Mandalay in BURMA the relationship between certain soil values such as clay percentage, loss on ignition, air-dry moisture content and moisture content in equilibrium with an atmosphere of fifty per cent. relative humidity, have been under investigation. The results show correlations between the sticky-point, moisture and loss on ignition, and this correlation is fairly free from the influence of bases.

In the PUNJAB, a method for the determination of the clay content of soils by moisture adsorption at 70 per cent. humidity has been developed. It is based on the observation of the vapour pressure curves of soils which consist of three portions corresponding with the three forms of hygroscopic moisture, namely, water of hydration, capillary adsorbed water and interstitial water. That for the capillary adsorbed portion depends on the total surface area of the soil and is represented by the straight portions of the curve lying between 10 and 70 per cent. humidity. The clay content can be calculated from the moisture adsorption values at 70 per cent. humidity.

(c) ***Base-exchange and the physical properties of soils.*** In the Irrigation Research laboratories at LAHORE a method has been developed for the estimation of exchangeable potassium and sodium in soils. Barium hydroxide is used as the replacing agent and potassium and sodium which appear in the leachate as hydroxides are determined by titration after precipitating calcium and barium as carbonates.

At COIMBATORE a study of the existing methods for the determination of exchangeable bases was made. For the deter-

mination of exchangeable calcium in soils containing calcium carbonate, Kelly's alcoholic potassium chloride method was found to give accurate results after applying a correction for dissolved calcium carbonate, after titrating the leachate and assuming the absence of magnesium carbonate. For determining the exchange capacity of soils, the barium hydroxide-ammonium chloride method gives higher results, especially with soils rich in organic matter. Crowther and Basu's method for determining exchangeable hydrogen and the degree of saturation has been found inapplicable to soils rich in organic matter.

In the Punjab Irrigation Research laboratories, LAHORE, a method has been developed which utilises the interaction between ammonia and soils for estimating the state of saturation and the pH values of soils. The degree of saturation with bases and the total adsorptive capacity of soils is determined by means of ammonia adsorption before and after treatment with dilute acids, and from these data the calcium requirements and pH values are calculated directly.

A method has been developed in Burma by which the total and exchangeable bases in soils are determined by titration methods. The soil is leached with 600 c.c. of one-twentieth normal hydrochloric acid and acidity and chlorine content of the leachate are determined by the usual titration methods. A correction for bases present as carbonate is made by determining the carbon dioxide. Leaching with acid, however dilute, causes decomposition of the exchange complex as can be recognised by the presence of appreciable amounts of iron and alumina in the leachate. The difference in the values of the two titrations gives the total value for exchangeable bases. The individual bases are estimated by the available standard methods. For soils containing carbonates, the amount of bases in the carbonate form is subtracted from the total, to obtain the sum of the exchangeable bases.

Investigations on the physico-chemical changes accompanying the process of reclamation of alkali soils in the PUNJAB have given some useful information. The ratio of univalent to

bivalent bases in the exchange complex of the soils is a measure of their deleterious qualities and the process of reclamation consists essentially in replacing the excess of sodium in the clay complex with calcium. By applications of calcium salts, accompanied by heavy dressings of farmyard manure, alkaline soils can be restored to normal conditions.

At the Sakrand Research Station in SIND, a simple method for the estimation of sodium in soils has been proposed. It consists in the removal of lime and sulphates in the acidified aqueous soil extracts with ammonium oxalate and barium chloride and the excess of barium is removed with ammonium carbonate. The filtrate is then evaporated to dryness, ignited and the residue is extracted with water, titrated with standard silver nitrate and the sodium equivalent of chlorine is calculated.

The cobalti-nitrite method of estimating potassium has been under investigation at the Indian Institute of Science, BANGALORE, and the conditions necessary for obtaining the potassium-sodium cobalti-nitrite precipitate in pure form, and the degree of accuracy of the method were determined.

At the Irrigation Research Institute, LAHORE, conductometric methods have been developed for the analysis of aqueous extracts of soils. It is claimed that they are both quicker and less expensive and well-suited for the routine analysis of a large number of samples.

A further study of the different soil layers in Sind has shown that at a depth of 18·5 ft. to 24·5 ft., a hard-pan layer exists which is rich in gypsum but not unusually high in alkali. The soil is rich in calcium and magnesium carbonates which tend to concentrate in the surface layers; the sum of hydrochloric acid-soluble iron and alumina remains uniform over the whole profile. Calcium is the predominating exchangeable base, and the average ratio of univalent to bivalent ions is 0·36.

From an investigation carried out in the Upper Chenab Canal area of the Punjab, it has been shown that a high correlation exists between the rise of the water-table and the monsoon rainfall, but that the correlation between the height of

the water-table and the amount of irrigation water supplied is even higher. It is concluded that the rise of the water-table can be controlled by relatively shallow storm-drains in an area of rising water-table which is not already water-logged.

Studies at COIMBATORE on moisture accumulation and movement in, and loss from, soil have shown that on the field scale, the moisture conditions vary directly as the mean daily rainfall and inversely with evaporation from the soil surface. The upward movement of water is limited to within a range of two feet below the surface and this movement is too slow to meet the demands of the growing crop. A surface soil mulch has not been found to exercise a protective influence on the evaporation of moisture from the soil, although the treatment contributes to crop increase. Deep ploughing helps in the retention of moisture and promotes economy in its use, but if too frequent appears detrimental to yields, due probably to the rapid oxidation of organic matter.

In SIND, investigations on the lateral movements of moisture and salts in soil have shown the existence of such movement of salts and that the salts determined the rate and the distance of such movement.

Interesting experiments on the effect of varying moisture conditions on the growth of the rice plant in typical rice soils are in progress in the CENTRAL PROVINCES. In pot culture experiments actual flooding was found better than watering when cracks appeared. The light rice soils of the Central Provinces show a lower pH value than the heavy rice soils, and when heavy land which has been under wheat is converted into a rice field the percentage of lime in the soil is decreased with a corresponding reduction in the pH. The Central Provinces rice soils vary in pH from 5·4 to 8·4. The optimum range of soil reaction appears to be pH 6·0 to 7·0 soils which tend to alkalinity do not give good yields of the finer rices though they may give fair yields of course and medium paddy.

At COIMBATORE the use of the antimony electrode for the determination of the pH value of soils has been under

investigation, and when equations connecting electrode potential were constructed, they were found to be somewhat different from those of Best. The effect of changes in temperature on the electro-motive force developed was investigated at the Irrigation Research laboratories at LAHORE and the use of standard antimony electrode in place of the usual calomel half-cell is recommended.

From a study of the factors affecting the determination of the hydrogen-ion concentration of the PUNJAB soils, no differences have been noticed in the values for soil-water suspensions shaken occasionally by hand and continuously by rocker. Within certain limits the ratio of soil to water has been noticed to have a marked effect on the pH value of suspensions. Keeping the amount of soil constant, it has been found that the pH value increases directly with the amount of water added until the ratio of one of soil to twenty of water is reached. Beyond this point any increase in dilution is attended with a fall in the pH value. With aqueous extracts of soils, on the other hand, dilution has no definite effect on the hydrogen-ion concentration. When aqueous suspensions of soils are kept for some time, a fall in pH is noticed irrespective of the soil-water ratios of the suspensions. This has been traced to bacterial activity in the suspensions and to the formation of sodium bicarbonate from sodium hydroxide.

At CALCUTTA UNIVERSITY an investigation on the nature of the reactions responsible for soil acidity have been in progress. The work in the main relates to studies in conductometric and potentiometric titrations and points to the conclusion that systems of colloidal acids and bases require a theoretical treatment different from that of acids and bases in solutions.

(d) Soil nitrogen and connected problems. In ASSAM interesting determinations were made of the amounts of nitrogen supplied to the soil annually by rain. At Sylhet weekly determinations of nitrogen in rain-water were made during twelve consecutive months in 1931-32, and the figures obtained were

much in excess of the usual values obtained elsewhere both as regards the total rainfall and the nitrogen content The high rainfall is explained by the fact that Sylhet is only 25 miles south of Cherrapunji in Assam, which has the reputation of having the highest rainfall in the world. The average for 28 years showed a rainfall of 457·80 inches, of which 428·13 inches fell between the months of April and September. The monsoon passes Sylhet to reach Cherrapunji; hence Sylhet receives a heavy rainfall, an annual average of 150 inches, and during the year under experiment 155 inches. Besides, the type of clouds which are generally noticed during Sylhet rains is cumulo-nimbus and these are frequently associated with thunder storms, which probably explain the higher percentage of nitric nitrogen than at Dehra Dun and Cawnpore, as observed by Dr. Leather, and at Rothamsted. The rain of Sylhet is also much richer in ammonia than that of the three other localities, due mainly to biochemical activity on the marshy lands under the tropical sun; it might also be due in part to city pollution.

These observations, when read with the data available from the other tropical and temperate parts of the world, contradict the opinion of Miller, that tropical rain does not supply to the soil an essentially greater amount of nitrogen than the rain of the temperate climates; and the statement that there is a greater content of nitric nitrogen in tropical rain and a greater content of ammoniacal nitrogen in non-tropical rain is not borne out.

The original observation made by the Agricultural Chemist, CENTRAL PROVINCES, that digestion of moist soil with sulphuric acid gives higher nitrogen values was confirmed, and further investigations at BANGALORE on the Kjeldahl method for the determination of nitrogen show that wet digestion or pre-treatment with water or dilute acid gives higher results than dry or direct digestion of dry soil with concentrated sulphuric acid. This is more in evidence in the case of heavy clay soils than sandy soils. Silica plays a protective role in forming a coating round the particle.

Investigations at COIMBATORE on the methods for the colorimetric estimation of nitrates in water and sewage have shown that dimethyl-alpha-naphthyl-amine is a better reagent than the alpha-naphthyl-amine usually employed in such estimations, and that for the oxidation of organic matter and nitrites, hydrogen-peroxide is preferable to potassium permanganate.

The University laboratories at ALLAHABAD have put forward further evidence to show that nitrification in the soils of the tropics is due more to photo-oxidation of ammonia and its salts by the oxygen of the air at the surface of the soil in presence of sunlight and accelerated by catalysts, than to the action of bacteria. Data were furnished to show that ammonia and its salts are nitrified in the presence of sunlight only.

The PUNJAB laboratories investigated the photo-nitrification of some compounds. When one per cent. solutions of urea and ammonium oxalate were exposed to sunlight for fourteen days in the presence of zinc oxide, 13·48 and 10·16 per cent. respectively of nitrogen was converted into nitrite and nitrate. Under similar conditions, appreciable oxidation of nitrogen was also obtained in one per cent. solutions of uric acid, hippuric acid, acetamide, glycocoll, ammonium acetate, dicyano-diamide, monoethyl-amine and diethyl-amine, sterile soil was much less efficient than zinc as a catalyst for the photo-oxidation of aniline. Animal charcoal was more efficient than zinc oxide as a catalyst for the oxidation of ammonium sulphate, but sterile soil has no effect. Sodium nitrite was oxidised to sodium nitrate in the presence of zinc oxide and sunlight. The presence of ammonia redicals in the nitrifying solutions indicated that organic compounds were first converted into ammonium compounds and subsequently into nitrite and nitrate.

At PUSA, nitrification tests have been carried out with oil-cakes containing different amounts of oil. Compared with cakes free from oil, the nitrification of gingelly cake (*Sesamum indicum*) containing 4-15 per cent. of oil has been affected by 10 per cent. in a soil rich in lime and 15 to 32 per cent. in a soil poor in lime. In an acid soil with pH 5·02, the nitrogen of

calcium cyanamide was nitrified much more readily than that of *sarson* cake or ammonium sulphate. On soils rich in lime, aluminium hydroxide and aluminium sulphate, when applied in concentrations up to 0·1 per cent., aluminium did not affect nitrification whereas in acid soil nitrification was reduced considerably. Addition of calcium carbonate at 0·2 per cent. neutralised the adverse effect of aluminium hydroxide, but not that of aluminium sulphate. Dicyano-diamide depressed nitrate formation in soils, while calcium cyanamide was toxic in culture solutions. According to experiments at Pusa, when cyanamide is added to certain Indian soils, no accumulation of nitrate occurs after inoculation for twenty weeks. Although fairly large amounts of ammonia accumulate in two to three weeks, complete nitrification of the cyanamide occurs however in 67 to 71 weeks. The delay in nitrification is due to the formation of dicyano-diamide which is toxic to nitrifying bacteria and which persists in these soils for an unusually long time. The fact that nitrification eventually occurs indicates that the dicyano-diamide does not kill the nitrifying organisms. Accumulation of ammonia is greater in the calcareous than in the non-calcareous soil, while the extent of nitrification is similar in both cases. In experiments with normally acid and desaturated soils no relation is found between the amount of lime water required to bring the soil to a definite pH value and the lime requirement as determined by the several well-known lime-requirement methods.

At INDORE a comparative study of the rate of nitrification of *karanja* cake, safflower cake and ammonium sulphate in a black cotton soil under different conditions of light and humidity was made. At high humidities ammoniacal nitrogen was higher and nitrate nitrogen lower than at the lower humidities. Under all conditions nitrates decreased rapidly in the third week and there was no loss of nitrogen. The algae growth which appeared simultaneously with the fall in nitrate content is considered a factor in decreasing the loss of nitrogen. In contradistinction to this, comparative studies in BOMBAY on the nitrification of

different oil-cakes in medium, black, laterite and garden soils, show that nitrogen loss occurs and that nitrification and the magnitude of the loss of nitrogen vary with the nature of the soil and the oil-cake. Black soil is the most and laterite soil is the least active in regard to ammonification and nitrification processes. The loss of nitrogen is the greatest with the most easily and quickly nitrifiable cakes.

Studies on the field scale, of the nitrification of organic and inorganic manures and of the fluctuations of nitrogen, were continued at COIMBATORE. As would be expected ammonium sulphate was the quickest to nitrify, followed by green manure and then by cattle manure. Two definite periods of active nitrification—a primary one at eight to ten weeks after the manures were ploughed in and a secondary one about six months later—were marked especially with ammonium sulphate. When the course of total nitrogen was followed, there was a distinct loss of nitrogen in the surface soils. This loss was greatest in ammonium sulphate plot and least in farmyard manure plot.

Studies on the nitrogen-recuperation powers of BOMBAY soils have been continued and additional interesting information has been obtained. The capacity of these soils to fix nitrogen increases with their calcium content, and superphosphate and tricalcium phosphate are about equal in effect. Phosphates in combination with potassium salts occupy a lower rank. Organic matter to the extent of two per cent. on the weight of soil is an aid to nitrogen-recuperation, but quantities greater than this were not of advantage. The addition of sugar has been shown to be deleterious to nitrification. The carbonate, sulphate and chloride of sodium do not help nitrogen fixation and are even deleterious; sodium chloride was the least harmful. These observations in the laboratory were confirmed by studies on a field scale. The nitrogen content of the soil was found to fluctuate from month to month to the extent of about 70 per cent. of the original nitrogen. Nitrogen recuperation occurs both under manured and unmanured conditions in the laboratory as well as in the field but under field conditions it is more pro-

nounced and continues for longer periods. The usual cultural operations, such as harrowing and inter-cultivating, exercise a great influence on the nitrogen content of the soil. The nitrogen-recuperation process starts with the wetting of the soil by the monsoon rains, and the partial drying and heating during the dry spells of the monsoon accelerate the process. The maximum is attained at twenty per cent. moisture and a soil temperature of 30° C. At Poona nitrogen fixation attained its peak in December in unmanured soils and earlier in manured soils.

The influence of finely-chopped *bajra* (*Pennisetum typhoideum*), maize plants, cowpeas and *dhaincha* (*Sesbania aculeata*) on nitrogen fixation in Pusa soils was studied. At two per cent. green matter on the weight of the soil the leaves of the *asoka* tree (*Polyalthia longifolia*) caused but little increase in nitrogen fixation. The addition of an aqueous extract of well-rotted manure increased fixation in the cultures containing *bajra*, maize and cowpea leaves. Fermentation of the green manure for one month before addition to the soil greatly increased nitrogen fixation in the maize cultures and to a less extent in the cowpea, *dhaincha* and sann-hemp (*Crotalaria juncea*) cultures, fixation being greater in cultures containing non-leguminous plants than in those containing leguminous plants. A significant amount of nitrogen was fixed in soil cultures containing artificial manure prepared by fermenting straw; unfermented straw had a smaller effect. Fixation of atmospheric nitrogen occurred in aqueous suspensions of cow and horse manure aerated for 21 days; this seemed to be due principally to the clostridium organisms present in the manure. Addition of straw increased the fixation of nitrogen in the manure suspensions. Aeration of the soil is the main factor in nitrogen fixation by organisms.

Investigations at LYALLPUR in the Punjab have shown that the nodule bacterium of berseem is absent in most soils, and that if the crop is to be successful, inoculation must be practised. The tops of berseem (*Trifolium alexandrinum*) grown from uninoculated seed contained 2·05 per cent. nitrogen and

the roots contained 1·25 per cent. nitrogen. The tops of plants grown from inoculated seed contained 2·43 per cent. nitrogen, while 1·58 per cent. nitrogen was found in the roots.

(*e*) ***Soil fertility.*** At DACCA and at COIMBATORE the possibility of utilising the electrical conductivity of soil suspensions as an index of soil fertility has been under investigation. Practically no change in electrical conductivity has been noticed in unmanured plots, but the addition of manures or fertilisers resulted in a marked increase in conductivity.

The laterite soils of the Konkan have been found to be too deficient in lime, phosphoric acid and nitrogen to produce a good crop of rice hence farmyard manure, green and dry leaves coupled with applications of bone-meal have a greater effect on grain formation than when soluble phosphates are applied.

It was noted in BENGAL that the yield and sucrose content of juice from cane grown on silt soils were higher than on red soils and also that the percentage of invert sugar was lower in the case of the former.

At SABOUR the soil conditions which were responsible for a peculiar yellowing sickness of sugarcanes in Bihar were under study. This condition was found to be associated either with a season of heavy rainfall which had the effect of washing all the available nitrates out of the soil and causing nitrogen starvation of the canes, or with a period of dry weather which raised the alkali and salt concentration on heavy or poorly drained soils to an extent that was toxic to plants. In some cases the pH of the soil rose above 9·0, which retarded the action of nitrifying bacteria. The application of nitrogenous fertilisers prevented yellowing and even led to the recovery of yellowed canes. The condition of the soil was improved by applications of gypsum or magnesium sulphate. Chemical analysis of yellowed canes gave some useful diagnostic values. The ash content was about the same as in healthy canes, but the nitrogen per cent. was distinctly lower. The glucose-nitrogen ratio was invariably high in unhealthy canes; with the Co. 213 variety the ratio was 7 to 8 for healthy canes but higher

for unhealthy ones. Successful ameliorative treatment was followed by a fall in glucose/nitrogen ratio. There was no significant difference in the pH value of the juice or leaf-sap of healthy and unhealthy canes. The yellowing disease appeared to be purely functional and neither fungi nor bacteria were associated with it.

Further experiments on solution cultures with rice plant were carried out at the Royal Institute of Science, BOMBAY. From a solution of ammonium sulphate there was greater absorption of ammonium ions than of sulphate ions at all stages of growth, but the absorption and also the absorption ratio of ammonium decreased as the plants aged. In the earlier stages of growth the maximum absorption of ammonium ions from different salt solutions was in the decreasing order—sulphate, phosphate, nitrate and chlorides. In the later stages of growth the order was sulphate, nitrate, phosphate and chloride. The absorption and the absorption ratios of nitrate ions increased as the plant aged, and were independent of the presence or absence of other ions. In the earlier stages of growth the maximum percentage absorption of nitrate from different nitrate solutions was in the decreasing order—ammonium, magnesium, calcium, potassium and sodium; in the later stages the order was ammonium, potassium, magnesium, calcium and sodium. The differential absorption is attributed to the differential permeability of the protoplasm at different stages of growth. From the point of view of fertiliser practice a mixture of ammonium sulphate and potassium sulphate was suggested as a better source of nitrogen for the rice plant than would be either salt alone.

In experiments at DACCA the percentage of nitrogen and potash in the roots, leaves and stems decreased rapidly from the transplantation to the flowering stage and then remained practically constant. While the percentage of silica and ash remained constant throughout the growth, phosphorus decreased rapidly in the leaves and stems, but underwent practically no change in the roots. Shortages in potassium and phosphorus

supplies were reflected in the composition of the plants but not of the seeds. In the absence of sufficient supplies of nitrogen and phosphorus, plants were often very rich in silica. The growth rate of the rice plant was at its highest in August. This holds good for the growth rate of leaves and the leaf-area ratio and for plants under different treatments. Of the three forms of manuring, the mixture of nitrate and ammoniacal nitrogen is the best. The ratio of straw-weight to grain-weight in unmanured plants is 2·8 : 1, in potassium nitrate series 2·6 : 1, ammonium sulphate series 2·4 : 1 and the mixture series 2 : 1. The maximum effect with a single dose of manure is obtained when the plants are manured with the mixture of the two forms of nitrogen. The substitution of sodium nitrate for potassium sulphate did not make any appreciable difference. With superphosphate alone the greatest increases in yield and carbo-hydrate contents were obtained when the application was made early (August 10th).

A preliminary study at COIMBATORE of the composition of bananas of varying degrees of keeping quality revealed a higher mineral content—particularly of potash—in the better keeping varieties. Plantains manured with ashes gave fruit with better keeping quality and sweeter taste.

(f) Composts. In the absence of adequate supplies of farmyard manure, the utilisation of all waste organic materials by converting them into manure by a simple, quick and economic process is the only means by which the very limited supplies of farmyard manure can be augmented. Experiments in this direction have been in progress in all the provinces and at the Indian Institute of Plant Industry. Besides waste, straws, crop stubble and other surplus and refuse matter of the farmstead, sewage, town-refuse and waste vegetation have been receiving attention. Several centres have reported that in the course of fermentation, a distinct loss of nitrogen has occurred from compost heaps receiving mineral nitrogenous salts irrespective of their chemical nature. Where small quantities of organic substances, like activated sludge or suspensions of dung

or faeces, have been added, an increase in nitrogen, due evidently to the fixation of atmospheric nitrogen, has occurred. Spraying with Bordeaux mixture or bleaching powder suspension helped to keep down foul smells in the compost heaps.

Bone sinews, which contain a high amount of nitrogen, have been found to decompose quickly and to be an excellent manure for rice in the seed-bed and in the bulk field.

At Palur in MADRAS a compost was prepared from cane trash, to which bone-meal and cow-manure were added at the rate of 50 and 200 lbs. respectively per ton of trash. At the end of four months the fermentation was complete and the product contained nitrogen 0·36 per cent., phosphoric anhydros (P_2O_5) 0·45 per cent. and potash (K_2O) 0·76 per cent.

Hydrogen peroxide attacked undecomposed straw to a slight extent. Water extracts contained more organic and inorganic matter than hydrogen peroxide extracts, but the amount of organic matter in the latter was more constant than in the former. It was suggested that the degree of rotting of manures could be determined by extraction with hydrogen peroxide.

(g) Manures, fertilisers and fertiliser practice. Various simple methods of pre-treating bones to render them more brittle and thus facilitate crushing for manurial purposes were investigated in BOMBAY and at PUSA. At POONA, treatment with sodium hydroxide or carbonate, boiling with water or autoclaving at 140° C. or dry-heating at 150° C. for five hours and charring the bones in direct contact with fuel, were all found very satisfactory.

At PUSA dilute solutions containing sodium hydroxide and sodium chloride were found to make bones soft in two months when kept out of contact with air. The crushed meal contained 25 per cent. organic matter, 30·0 per cent. P_2O_5, 3·5 per cent. organic nitrogen and 2·0 per cent. free sodium hydroxide.

Investigations have been in progress in MADRAS to devise rapid and cheap methods for making rock phosphate available

to plants by the process of sulphonification by sulphur-oxidising organisms. Laboratory experiments and pot cultures have shown that pH 4·5 to 5·0 is an index of phosphate availability in the compost. When the soil *plus* phosphate compost contained 25 parts or more of cattle manure, six parts of sulphur were necessary.

In the PUNJAB comparative experiments with bone-meal and superphosphate have shown that many grades of bone-meal on the market are not sufficiently fine, and that phosphate availability increases with fineness. Treatment with urine, farmyard manure and ammonium sulphate increased the availability of the coarser grades of bone-meal.

In MADRAS, Kossier phosphate possessed no advantage over bone-meal when applied to paddy.

At PUSA the interaction between superphosphate and the local soils was investigated. The uncertain action of superphosphate as a fertiliser for these soils is attributed to its high gypsum content and is thought to be due to precipitation of insoluble calcium phosphates with consequent reduction in phosphate concentration, together with excessive concentration of sulphate ions.

In BENGAL experiments to find out the optimum ratio of nitrogen to phosphorus (N : P_2O_5) for paddy have given indications of a ratio of 1 : 1 for silt areas and 1 : 3 for red soils.

Experiments were carried out at MANDALAY with manures and fertilisers on soils of known physical and chemical composition. Synthetic farmyard manure prepared from straw, ordinary farmyard manure and straw, when applied at 50 lbs. per acre, increased the yields of paddy grain by 34·67, 35·1 and 18·9 per cent. respectively, as compared with an increase of 26·47 per cent. from ammonium sulphate and calcium carbonate. Coarse rice-bran, containing 1·93 per cent. nitrogen and applied at 20 lbs. of nitrogen per acre, increased yield by 1·7 to 28·9 per cent. in three seasons. A compost of water hyacinth which contained 0·269 per cent. nitrogen, 0·208 per cent. P_2O_5

and 0·759 per cent. K_2O gave good results when applied at 10 tons per acre. Ammophos, Nicifos, Leunophos, Diammophos and other ammonium phosphate fertilisers increased paddy yields in many cases. Superphosphate and basic slag increased the yield approximately 7 to 32 per cent. in different years and on different soils; basic slag seemed to have a beneficial effect on paddy soils apart from its fertiliser value. Urea and calcium cyanamide were not as effective as ammonium sulphate as sources of nitrogen for paddy.

In similar experiments with sugarcane at PUSA it was noted that the application of nitrogenous manures increased the yield but lowered the quality of the juice, whereas sulphate of potash and super, when applied alone, improved the quality. Combinations of super, potash and mustered cake produced better quality juice than that obtained either by cake alone or in combination with either potash or super.

In the PUNJAB, while nitrogen as potassium nitrate was found to hasten maturity of Co. 223 sugarcane, nitrogen as ammonium sulphate or ammonium phosphate delayed ripening. For the Palur tract of the MADRAS PRESIDENCY, a dressing of 200 lbs. of nitrogen as ammonium sulphate on a basal dressing of cattle-manure equivalent to 25 pounds of nitrogen gave the largest yield. The best all-round results were obtained with a mixture of oil-cake and ammonium sulphate, while the latter by itself gave a poor quality jaggery. On these soils sodium nitrate, either alone or in combination with groundnut cake, was inferior to ammonium sulphate as a source of nitrogen for sugarcane. It was found that the stickiness and softness of jaggery produced from cane fertilised with ammonium sulphate increased with the amount of ammonium sulphate used.

Ammonium sulphate was found to be beneficial to cotton in the PUNJAB and SURAT, while in MADRAS it was of no advantage. According to experiments at SURAT the application of fertilisers to cotton appreciably alters the mean number of buds, the mean proportion of flowers of bolls to buds. The variability of the production of flowers is altered, but the mean number of flowers

and bolls is unaltered by fertiliser treatment. The effect of ammonium sulphate as a fertiliser for cotton at 40 lbs. and 100 lbs. of nitrogen per acre was to increase at both nitrogen levels the number of buds, but had no effect on checking the shedding of buds.

Experiments in the PUNJAB on the manuring of citrus plants with fertilisers independently and in combination have been in progress. Artificial nitrogenous manures in combination with farmyard manure appear to be most beneficial.

The effect on seed's germination of contact with chemical fertilisers was investigated in BOMBAY. When ammonium sulphate was applied at the rate of 100 lbs. per acre, the injurious effect on the germination of cotton, *juar* and *bajri* seeds was greatest when the mixture of seed and salt was dibbled in pinches. The injury was somewhat less when the seed and fertiliser were applied out of contact with each other. Contact of the fertiliser with the seed for two days had no effect on germination. Failure of germination occurred only when the fertiliser came in concentrated and direct contact with the seed under soil conditions favourable for germination.

Application of fertilisers in partial doses after transplantation prevented lodging of paddy in MADRAS. In experiments to ascertain the best time for the application of ammonium sulphate to the rice crop it was found that applications made one or two months after transplanting was attended with the best results in yields.

Experiments at PUSA have established the existence of a definite correlation between the incidence of plant disease and the type of manurial treatment in the case of the wilt *Fusarium vasinfectum* of *Cajanus indicus*. Neither moisture content nor pH of the soil was found to have any effect but manuring with superphosphate or cattle-manure increased wilt, while a green manure like *Crotalaria juncea* had the reverse effect. When, however, green manure was combined with superphosphate, there was an increase in the number of wilt-affected plants.

2. Agricultural Meteorology.

The period under review saw the inauguration of the scheme of Agricultural Meteorology, financed by the Imperial Council of Agricultural Research. The scheme is to run on a restricted scale for three years and is to be in charge of a single Agricultural Meteorologist. The staff was recruited and work commenced at the Meteorological Office, Poona.

The work of this new scheme can be classed under two heads: (*a*) statistical and (*b*) experimental. The programme of statistical investigation is to begin with a critical enquiry into the available data on the area sown and yield per acre of crops for the various presidencies and districts in India and proceed, after careful selection, to correlate some of them with the accumulated meteorological data. Accordingly, the Agricultural Meteorologist got into touch with the provincial agricultural departments and began to collect the available Season and Crop Reports and the data of some of the experimental farms. A beginning was made in the subject of correlation of the yield and acreage figures of the Bombay Presidency with special reference to the cotton crop. To discuss the various problems of agriculture in relation to weather, the Agricultural Meteorologist met the various officials of the Department of Agriculture, Bihar and Orissa, assembled at Patna during the Science Congress week in January 1933, and later visited the Imperial Institute of Agricultural Research, Pusa, the office of the Director-General of Commercial Intelligence, Calcutta, the Agricultural College at Cawnpore and a few other places.

Suggestions regarding the equipment for an agricultural meteorological observatory, the method of taking observations and other technical advice were given by correspondence on request, to about twenty agricultural research institutions or workers.

In order to help agricultural workers who may wish to get training in agricultural meteorological observation and to standardise the instrumental equipment and the methods of observations suited to agricultural needs, a model observatory was

started in the farm of the local Agricultural College, and arrangements were made to study the variations of climate inside different crops. Arrangements were being made for starting regular observations of temperature and moisture in the air and in the soil, evaporation from water and soil, percolation of water through the soil, radiation from the sun and the sky and for studying the meteorology of the air layers near the ground. Some instruments for the measurement of air, soil, and plant temperatures and evaporation of water were got made locally, and these were under test. The Branch would seek the co-operation of various agricultural departments in order to arrange for detailed meteorological observations to be collected side by side with crop observations in at least a few important centres.

In the extreme north-west of India the occurrence of frost in the winter months is usual every year. The month of January 1933, however, was marked by widespread and more frost, reaching much further south than usual. Crops were heavily damaged in Bihar where local enquiries showed that such weather had not been experienced for about forty years. At Pusa the crops which suffered most were tobacco, chillies, pigeonpea and certain varieties of wheat. Damage from frost was most severe in lands which were deficient in soil moisture, and in the case of wheat the extent of damage appears to depend largely on the stage of maturity of the plant when the frost occurs, early-maturing types such as Pusa 4 suffering most severely in Bihar.

A comparison of biometrical constants in Pusa 4 wheat for the year of the frost and the seven preceding years showed that, while the length of ear-head in the 1933 crop was not statistically different from that of other years, yet the average number of grains per ear was definitely reduced. The effect of the frost is also apparent in the increased coefficient of variability of the number of grains per ear and the decreased coefficient for correlation between this character and length of ear-head. A paper from Pusa records these facts.

A statistical study of the correlation between frost and the preceding meteorological conditions has been carried out in the PUNJAB. An examination of temperature records at Lahore shows that frost occurs in winter either in the cold wave in the rear of a western disturbance or during an unusually long spell of clear and dry (anticyclonian) weather. Within $\pm$ 2 per cent. the minimum temperature of the air on a clear night in Lahore can be foretold from the wet and dry bulb readings of the previous afternoon with an accuracy of 93 per cent.

3. Plant-breeding and Genetics.

The work of the plant-breeder has for its object the improvement of agricultural produce either in quality of yield. At the present time, when prices of agricultural produce are low, the improvement of the quality of agricultural produce offers a more promising field of research, in the economic sense, than the production of high-yielding varieties. It is, however, not possible to draw a sharp line of demarcation between these two goals of the plant-breeder.

Improvement in the quality of a crop may result from the production of a type which is resistant to disease and the reduction of the loss due to disease will inevitably be reflected in increased yields. Again the labours of the breeder may result in the evolution of types which possess a shorter life-cycle than that of the established variety; such a property will inevitably lead, in the case of a North Indian *rabi* crop, to an extension of the area of the crop towards the South, where an earlier hot weather necessitates an earlier harvest and consequently increased production. It is evident, therefore, that the present economic depression militates heavily against the chances of the plant-breeder producing results of immediate economic significance. Notwithstanding this, however, steady progress has been achieved in India, both as regards results of immediate importance and in laying the foundation for future developments in more prosperous times.

Rice. Rice is perhaps the most important cereal crop in India and the normal activities of those agricultural departments which are concerned with this crop have, in several cases, been supplemented by the establishment of special rice research sections financed by the Imperial Council of Agricultural Research. In BURMA the basic classification of indigenous rices has already been completed by the agricultural department and further work on selection and hybridization is in progress. Particular attention is being paid to quality, for especially since the war, Burma rice has waged a losing fight in European markets with the finer quality rices of Spain and Italy. The Burmese cultivator prefers coarse, chalky rices for his own food consumption, but these do not appeal to the buyer abroad who likes translucent, clean-looking grains. With the object of evolving good-quality, high-yielding rices, crosses have been made between exotic and indigenous varieties and between the latter themselves, and some promising hybrids have been obtained. Cultures have been obtained ranging in life period from 155 to 175 days and those of high-hulling percentage have been selected for further study. In BENGAL the classification of the rices of the province has been completed and published and promising new types are being tested for distribution. In BIHAR AND ORISSA a comprehensive scheme of research is in progress. Studies on the effect of meteorological factors on the opening of flowers and the dehiscence of anthers, the effect of spacing and the reaction of the root-system to different soils are combined with selection and hybridization work. The rices of this province have also been studied at the Imperial Institute of Agricultural Research and the indigenous types have been classified and described. The course of colour development in the vegetative and floral organs of the paddy plant has been studied in great detail. Further work on the testing of certain of these types is in progress at PUSA. At the Botanical Sub-Station, KARNAL, about 125 types of paddy have been isolated from samples collected in North India and the classification of these types is in progress. In MADRAS, ASSAM and the remain-

ing provinces, the selection and testing of high-yielding types is in progress and the study of the inheritance of characters in this crop, which was initiated many years ago by Hector and Parnell, is being continued by Ramiah in Madras and by Mitra in Assam. A number of papers on this subject have appeared in the *Indian Journal of Agricultural Science* during the period under review.

Wheat. Wheat-breeding has been the subject of intensive study in the United Provinces, Punjab, Sind and other provinces which are interested in this crop. At the Imperial Institute of Agricultural Research, PUSA, and at its Botanical Sub-Station, KARNAL, the testing of the selections from crosses between Pusa 52 and Federation and Pusa 4 and Federation is in progress, and an extensive series of trials have been laid down on farms in the United Provinces and the Punjab with the object of making a reliable comparison between the Pusa wheats and the best selections bred by the local departments. From a study of the incidence of the loose smut disease in wheat at Karnal, it appears that the wheat Pusa 114 is probably highly resistant to this disease; Pusa 114 has also been found to be very resistant to rust in Sind and may have a future before it on account of its resistant properties. The milling and baking qualities of this wheat are excellent. Important work on the incidence of rust on wheat is in progress at the Rust Research Station financed by the Imperial Council of Agricultural Research, and the breeding of resistant types is being commenced. This subject is dealt with more fully in a subsequent section.

Barley. Barley has been the subject of investigation at Pusa: twenty-four types have been isolated and repeated tests have established that T. 21 is a very high-yielding type in Bihar. Recent experiments at Karnal, however, indicate that in the more northern tracts of India T. 21 will not succeed but that other types, especially T. 13, may prove very heavy-yielders. This result agrees with an ecological study of the relationship between the root-systems

of the different types and their distribution in India which has already been published. Cross-breeding between different types, combined with a histological study, has shown that the property of lodging depends upon the nature, degree of development and distribution of mechanical tissues in the stem and that these characters are subject to normal Mendelian inheritance. The mode of inheritance of several other characters has been studied.

A study of the resistance of the various types of barley to *Helminthosporium* disease and of the inheritance of resistance is also in progress at Pusa.

Oats. Oats are a relatively unimportant crop in India in an economic sense. The Indian oat belongs to the species *A. sterilis* and interspecific crosses have been carried out between this and certain exotic varieties of the species *A. sativa* at Pusa. The results are fully described in a recent publication; high-yielding hybrids having heavier grain bushel weight and stronger straw than the indigenous types have been obtained.

Gram. The first publication on the inheritance of characters in Indian gram came from the Botanical Sub-Station, Karnal, in the form of a paper describing the inheritance of petal colour. The red and blue colours were found to depend upon two complementary factors, while a third factor was responsible for the green colour in the standard of certain *Kabuli* grams. Yield tests with the new types of gram isolated at Pusa and Karnal have suggested that the new Type 58 will surpass the established Types 17 and 25 in yielding power. The study of types and their yielding properties is also in progress in the United Provinces and the Punjab.

Pigeon-pea. Pigeon-pea has been investigated by the Imperial Institute of Agricultural Research and by the Central Provinces Department of Agriculture. At Pusa the types have been described and their reaction to wilt-disease has been studied. Several types which are almost immune to this disease have been obtained and the results of this work are

now published. A study of the inheritance of the property of resistance has shown that this character depends upon the segregation and recombination for multiple factors of which none appears to be linked with the factors for morphological characters. It is, therefore, theoretically possible to obtain resistance in any phenotype. It is not to be expected that resistant types bred at Pusa will show resistance all over India; the possibility of different physiological strains of the parasite must be kept in mind, and the selection of resistant types for local conditions is, therefore, also proceeding in the Central Provinces.

Lentils. Work on lentils is proceeding in Assam and Bengal, and on *urid* (*P. radiatus*) and *mung* (*P. mungo*) in Bengal, Bihar and Orissa, United Provinces and the Central Provinces. The Imperial Institute of Agricultural Research is also devoting considerable attention to these crops.

Sugarcane. During the period under review, a Sub-Station for sugarcane work, financed by the Imperial Council of Agricultural Research, was opened at Karnal. Work was continued at Coimbatore on the sorghum hybrids and out of 7,500 seedlings, sixty were selected for further study. One of these, Co. 352 appears very promising under Coimbatore conditions, ripening in six to seven months and maintaining its juice for another three months. It has a sucrose percentage of 17·9 and coefficient of purity of 87·46. Cytological work on the chromosome numbers of types and hybrids has been commenced and will undoubtedly yield results of considerable scientific interest. Breeding of thick canes for tropical India was continued and detailed cytological studies of the relation of chromosome number to size of nuclei were carried out.

In Bihar and Orissa, where the sugar industry has made such marked developments, a cane research station, financed by the Imperial Council of Agricultural Research, has been established at Mushari. Work here has suggested that it may be possible to secure fertilisation and raise cane from seed in Northern India.

Cotton. The improvement of the cotton crop has been the subject of work in Madras, Bombay, the Central Provinces, Sind and the Punjab. Selection, the acclimatisation of exotics and hybridization are all being attempted with a view to evolving improved types. In the Punjab satisfactory strains resistant to Jassid have been evolved and arrangements have been made for a small experimental ginnery at Lyallpur at which excellent facilities are provided for the ginning of the large number of pure varieties which are under trial.

The inheritance of corolla-colour in Indian cotton has been described in a paper from Bombay and a study of leaf-shedding has been carried out at Lyallpur.

Oil-seeds. Linseed and sesamum are two of the most important Indian oil-seeds. Linseed has been the subject of extensive gentical researches at Pusa and is also being investigated in the United Provinces, the Punjab and Central Provinces. The recent Ottawa Conference has accorded preferential treatment to Indian linseed in the markets of the United Kingdom. For export a white or yellow-coloured seed of high oil-content is required and the genetical work at Pusa has, for its economic object, the production of a linseed of this type. Generally speaking, it is believed that high oil-content is associated with large size in linseed and, because of this belief, " bold " seed commands a higher price than the small-seeded types. The cross-breeding work at Pusa has, however, resulted in the production of types with high oil-content and seed of medium size. Some of these hybrids are about equal in yielding power to the small-seeded Types 12 and 121 which have been distributed to growers for many years past. They are being tested for yield at Pusa and distributed to provincial departments for trial.

At PUSA the seventh generation of hybrids from the crosses, the results of which have been published, and the fifth generation of another set of crosses consisting of Type 1 × Type 15, Type 12 × Type 15, Type 22 × Type 15, Type 1 × Type 102, and

Pink × Type 1, were grown. The results of this latter set are yet to be described.

A yield-trial experiment was run with five out of a number of promising hybrids, and the standard Type 12 both in "Randomised Blocks" and "Latin Squares". Type 12 proved the best yielder and Hybrid 10 and Hybrid 13 were second and third respectively in all the three trials. Hybrid 63 was fourth in two trials and fifth in the third. Hybrid 11 was fourth in one trial, fifth in another and sixth in the third. Hybrid 2 was fifth in one and sixth in two trials.

The second generations of the crosses—Type 15 × Type 4, Type 15 × Type 21, and Type 15 × Type 24—were grown and studied.

In the cross Type 15 × Type 21 (in which Type 15 has white and Type 21 blue petals), the F_1 was white and in F_2 a ratio of 3 white to 1 blue was obtained, suggesting dominance of white over blue, a condition the reverse of that observed in other crosses. A careful examination of the flowers of F_1, however, showed a very faint bluish tinge on the apex of the petals which was more clear in the buds. Many of the white F_2 segregates also showed this blue tinge and a correct diagnosis of the pure whites and the bluish whites was finally made. The ratio of the bluish whites to whites was nearly 2 : 1—the larger group is, therefore, the blue heterozygotes and the cross agrees with other crosses in the dominance of blue in the petal.

Some back-crosses and new crosses have been made with the above parental types in order to throw more light on the genetic constitution of the above types and particularly on that of Type 15.

The linseed and flax varieties received from Australia were grown for the second season in succession. Very late varieties either did not produce good, healthy seed or altogether failed to set. The work of isolation and fixing of varieties from amongst these was continued. Excepting Type 12 and Hybrid 26 all the rest of the samples (108) show an increase in oil-content.

The average oil-content of last year (1930-31) for 108 samples was 39·57 per cent. and that of 110 samples for this year (1931-32) is 42·75 per cent., *i.e.*, there is an increase of 3·18 per cent. in the oil-content this year over last year's figure.

The maximum oil-content in any samples was 43·50 per cent. for 1930-31 and that for 1931-32 is 47·42 per cent. Similarly the minimum oil-content for 1930-31 and 1931-32 was respectively 34·55 per cent. and 37·29 per cent. Thus, there is an increase of 3·92 per cent. in the maximum and an increase of 2·74 per cent. in the minimum this year over the last year's figures.

Statement showing the oil percentage of some linseed hybrids and the standard types from 1928-29 to 1931-32 (4 years).

Variety	Oil percentage				
	1928-29	1929-30	1930-31	1931-32	Mean
Type 12	36·67	36·93	37·68	37·29	37·14
„ 121	40·01	40·13	38·88	41·50	40·13
„ 124	38·22	39·86	37·44	42·30	39·45
H. 2 (Type 1×Type 12)	40·99	40·47	40·78	45·07	41·83
H. 10 (Type 12×Type 1)	43·00	42·20	41·49	45·50	43·05
H. 11 („ „ „)	43·13	43·25	43·50	46·55	44·11
H. 13 („ „ „)	40·14	39·49	39·32	41·79	40·18
H. 63 (Type 121×Type 11)	44·64	41·52	43·37	44·91	43·61
H. 55 (Type 8×Type 121)	44·03	40·26	42·23	44·73	42·81
H. 21 (Type 12×Type 8)	41·80	39·74	37·66	42·20	40·05

Testing of the ninety hybrid linseeds obtained from crosses, the results of which have already been published, was continued. Two hybrids, H. 55 and H. 21, were found to be equal to the standard Type 12 in yielding power and to possess higher oil percentage. Both these hybrids have the " white " seed colour which is more popular with the trade than the dark. Further tests with these and other hybrids will be continued.

Some types of linseed from Australia were grown, and it is possible that a use may be found for them as parents in crosses with Indian linseed. The Australian types possess large flowers, but their oil-content in the past season was low. Further work on these types is needed; at present, they appear to be mostly too late in maturity for Indian conditions.

In the PUNJAB fifty-seven pure types of linseed have been isolated and are being tested for yield; some of the selections have already proved superior to the local crop in this respect.

In the CENTRAL PROVINCES a high-yielding selection has been produced and crosses between local types and certain rust-resistant Pusa varieties have been carried out. A morphological and physiological study of the root-system of different types and their relation to the soil is in progress.

In the UNITED PROVINCES the testing of local types in comparison with Pusa types, is in progress with the object of obtaining a selection suitable for the eastern tracts of the province.

Sesamum has been investigated at Pusa, in the Central Provinces and in the Punjab. At both places, types have been classified and are being tested. About thirty types were obtained at Pusa, of which Types 3 and 29 have proved heavy-yielders. A desirable type should possess high oil-content, high-yielding power and white seed and with the object of improving the existing types in these respects, cross-breeding is in progress.

Brassica is perhaps the most widely grown oil-seed in India. The crop is the subject of extensive study in the Punjab and at Pusa. In the Punjab some very promising selections of *sarson* are in hand and as a result of inter-crossing the yellow and brown seeded forms, the brown seed character has been combined with the property of self-fertility. From this material, it should be possible to evolve high-yielding self-fertile strains.

At Pusa most of the varieties under investigation were self-sterile and the amount of setting in cross-pollination was much higher than in self-pollinations. Self-sterile varieties could be made to set a good amount of seed when buds (one to

two days before opening) were selfed with pollen from different branches, but the progeny of self-fertilized seed seemed to lose vigour and fertility. It was shown that in cross-pollinations (compatible matings) the pollen tube reached the ovary in a shorter time than in self-pollinations (incompatible matings), and that the sterility in compatible matings was due to the failure of the pollen tube to reach the ovule before it had lost its receptive power. The self-sterile varieties were adapted to cross-fertilization, which was brought about by bees that visited the flowers in large numbers on sunny days. It was probably due to the cross-fertilization that the vigour and the fertility of these sterile varieties were maintained.

The tentative classification of the types of *Brassica* in the three self-fertile species, *viz.*, (1) yellow *sarson* (*B. campestris* var. *sarson* Prain); (2) *rai* (*B. juncea* Hooker); (3) Chinese mustard (*B. rugosa* var. *cuneifolia*, Prain) was checked and revised in 1931-32. Herbarium specimens of all the self-fertile and self-sterile groups of *Brassica* were prepared and sent to the Royal Botanic Gardens, Kew (England) for identification and confirmation of our classification of these groups.

The F_2 generations of the crosses between yellow *sarson*, a self-fertile group, and black *sarson* and Burma *sarson* belonging to the self-sterile groups were studied at Pusa to elucidate the inheritance of self-fertility and of seed characters. These crosses were:—

(1) Yellow *sarson* × black *sarson* late (*B. campestris* var. *oleifera* Prain) and its reciprocal.

(2) Yellow *sarson* × Burma *sarson* (*B. oleracea* var. *chinensis* Prain) and its reciprocal.

Similar crosses between yellow *sarson* and *toria* (*B. napus* L. var. *dichotoma* Prain): and between yellow *sarson* and black *sarson* early (*B. campestris* sub-sp. *napus* var. *dichotoma* Duthie and Fuller) were studied at the Botanical Sub-Station, Karnal. The consideration of the mode of inheritance is made difficult by the fact that the self-sterile groups cannot be pure for the different characters. Some definite idea about the scheme of

inheritance will be got next year from the study of the F_3 generations of the crosses. At present it appears that self-fertility is dominant over self-sterility, and that red seed-colour of *toria* or *sarson* is dominant over yellow seed-colour of the yellow *sarson*.

Work on castor and groundnuts is in progress in many provinces.

Work on safflower is being done at the Imperial Institute of Agricultural Research and in the United Provinces. Patwa (*Hibiscus*) is dealt with at the Imperial Institute of Agricultural Research and also in Bengal.

Ganja (*hemp*) is claiming the attention of the Agricultural Department in Madras and in Bihar and Orissa, and at the Imperial Institute of Agricultural Research a number of strains have been isolated by mass-selection.

Potatoes have been the subject of investigation in Assam, the United Provinces and the Punjab. A scheme is under consideration for establishing a Central Research Station for this crop where breeding work, which it is hoped will include South American types, will be carried out.

Other crops. During the period under review a number of papers have been published dealing with the genetics of Indian crops of less importance than some of those mentioned above. From Pusa there have been papers dealing with the isolation of pure types in tobacco and an extensive study of the genetics of the chilli (*Capsicum*) has been carried out. The cytology of gram has also been studied at Pusa, and from Coimbatore there has been a series of papers dealing with the inheritance of characters in millets, chiefly *ragi* (*Eleusine coracana*).

In Madras considerable work on the genetics of several millets has been done. In the finger millet or *ragi* (*Eleusine coracana* Gaertn.), anthesis has been studied and also the inheritance of length of ear-head. Two factors, E_1 and E_2, determine this length: a very short, short or long ear-head results accordingly as both factors are absent, or one or both are present. A factor Q determines the density of disposition of the

spikelets. The factors E_1, E_2 and Q are independent of the factors for purple pigmentation in the plant, grain colour and unripe pericarp colour.

Two factors H_1 and H_2 control the depth of purple pigmentation in the glumes.

In the Italian millet (*Setaria italica* Beauv.) the mode of inheritance of bristles in the head has been worked out. The bristles fall into four groups, namely, long, medium, short and dwarf. The last represents the basic condition and is due to a factor X. Three other factors, E_1, L_1 and L_2 acting on X, are responsible for the other lengths met with. These factors are independent of those for grain and anther colours.

The colour characters in the great millet (*Sorghum*) have received much attention. Here it has been found that the colour of the leaf-sheath and colour of the glume go together. Purple pigment dependent on the factor P is dominant to brown colour. Within the P group, a factor Q may modify purple into reddish purple.

Yellow (factor Y) is the basic grain colour and R and W interact with Y to produce the red and white colours. Brown colour is produced by the action and interaction of two factors, B_1 and B_2. Dry anther colours run parallel to grain colour.

There is a linkage probably complete between the factors for leaf-sheath and glume-colour and those for brown colour in the anthers and grain. Pearly grain (Z) behaves as a simple dominant to chalky (z).

In the pearl millet (*Pennisetum typhoideum* Rich.) anthesis has been studied.

4. Plant Physiology.

The physiology of the cotton plant has been the subject of extensive study in Surat, Sind and the Punjab.

The important research scheme conducted at SURAT aimed at finding out the reason for the shedding of eighty to ninety per cent. of the buds and bolls and ascertaining how far this loss can be reduced. The main discovery is that the cause is

nutritional and that this phenomenon is not due to insufficient moisture in the soil. It has been ascertained that the nitrogen in the cell-sap is relatively much less in the latter part of the season than earlier, and hence the bolls which form in the early part of the season have at their disposal a larger amount of nitrogen than the later bolls. This means that every effort should be made to promote an early crop. There are two principal ways in which action can be taken to this end :—

(1) Protecting the crop from boll-worm.

(2) Sowing the seed on ridges or hillocks so as to eliminate the risk of having to sow a second or third time as the result of excessive rainfall, which is a common phenomenon in the Surat tract.

Another important discovery is that the plant is most in need of nitrogen in the latter part of the monsoon and hence manuring should be planned to meet this demand, where this is possible.

Finally, certain plant selections have been made which appear to possess the character of retaining bolls more efficiently than the average crop. One of these strains has been registered under the number " 43 ", and it will be further tested by the Deputy Director of Agriculture, Gujarat.

In SIND, the Cotton Physiological Research scheme, financed by the Indian Central Cotton Committee, completed its sanctioned period of five years during the year 1931-32. A final report on the five years' working of the scheme was submitted to the Indian Central Cotton Committee. The Committee approved the report and extended the scheme for a further period of five years at a total cost of Rs. 1,62,854.

As a result of the past five years' work, conclusive results have been obtained which must now be adopted into general cotton cultivation through the agency of the district demonstration and propaganda staff. It has been proved that the optimum period for cotton-sowing under Barrage conditions is prior to the middle of May, and that sowings even as early as the first fortnight of April give good results. Sowings later than the

20th May give inferior outturns. The water requirements of the cotton crop at Sakrand have been shown to be approximately 37 inches total delta, distributed over a period of five months. On dry virgin soils, higher waterings tend to increase yield to begin with but, after cultivation has been carried on for a season or two, increased watering is not economical. Work is being carried on to ascertain the best intervals of watering the crop under a fixed duty in order to obtain the maximum yield.

Research into the movement of available nitrogen in the soil has shown that the cotton crop utilises a very considerable amount of this fertilising constituent during its growing period and that shortage of nitrogen is liable to occur at the times of flowering and fruiting. Accordingly, experiments have been commenced to ascertain the effect of applications of quick-acting nitrogenous manures to the crop at critical periods of its development.

Future work under the scheme includes (*a*) a complete investigation of the nutritional requirements of the cotton plant, (*b*) a study of the economics of the application of irrigation water in relation to final yields, (*c*) research into the causative factors of " red leaf blight " which limits the successful extension of certain superior imported varieties, and (*d*) investigations into the factors affecting the development of sound seed of high germinating capacity in the cotton crop.

During the year 1932-33, the Cotton Physiologist and his staff were engaged upon very important investigations into the nutritional requirements of the cotton crop at different stages of growth, the economics and technique of the application of irrigation water in relation to final yields, the causative factors of " red-leaf " blight which limits the successful extension of certain superior types of imported cottons and the conditions requisite to the development of sound seed of high germinating capacity in the cotton crop. A brief summary of the year's work is given hereunder :

Particular attention was given during the year to experimental work on the best methods of distributing irrigation

supply, within a fixed " delta " to the cotton crop in order to increase final yields. Results so far obtained indicate that the reduction of intervals between waterings at flowering and fruiting time, *i.e.*, August-September, is beneficial. Another main item on the research programme dealt with the effect on cotton yields of the application of quick-acting nitrogenous manures at critical periods of crop growth. Significant results were not obtained as the experimental area was badly affected with " red leaf " blight and boll development was considerably below normal. Both the above-mentioned investigations will be continued for several years. The factors responsible for the " red leaf " phenomenon are under investigation and work on the breeding of resistant types is also in progress. The problems affecting the development of sound seed are associated with investigations of soil conditions and plant nutrition and these factors are being studied at all stages of the growing period. Minor investigations into the control of white-ant attack on the cotton crop and the relationship between root development of different varieties of cotton and their adaptability to environmental conditions in Sind were also continued. The small meteorological station in the physiological section maintained complete records of air and soil temperatures, humidity, rainfall, wind velocity and direction, etc., throughout the year, all of which data are invaluable in the work of the scientific sections at the Agricultural Research Station, Sakrand.

In view of the great extension of cotton cultivation in the Barrage areas of Sind, the current research work under the Physiological Research Scheme is of the greatest practical importance. The general advancement of the average cotton-sowing season in Sind, on the basis of results already obtained at Sakrand, would mean many lakhs of additional profit to the growers and, especially in the American tracts, every effort should be made by Government to supply irrigation water for cotton sowings not later than the end of March. The financial

benefit of even a slight reduction in the percentage of boll-shedding as a result of minor modifications in irrigation practice or cultural treatments, would fully repay the generosity and foresight of the Indian Central Cotton Committee by whose financial assistance the work of the Cotton Physiological Scheme is being carried on and developed.

In the PUNJAB a study has been made of the development and shedding of leaves of cotton. It was found that the appearance of successive leaves on the main stem was affected by the prevailing temperature, but that there was no correlation between the interval in the appearance of successive leaves on the main stem and the length of internodes. The age of leaves at the time of shedding varied considerably during the course of the season.

The physiology of the rice plant has been investigated in Bombay. The osmatic pressure in roots and leaves was investigated and in all cases showed a periodicity rising as the season advances and then falling. The effect of different salts on the osmatic pressure was used to determine which salts were essential for the growth of the rice plant. The osmatic pressure was found to rise when the rice plant was grown in a salt solution which was absorbed by the plant.

The photo-synthetic activity of the leaves was also investigated and a marked periodicity was determined, the rate of assimilation rising soon after transplantation and remaining fairly uniform until a depression takes place at the end of the life-cycle, which is followed by a second rise and fall. A study of the nitrogen absorption by the rice plant showed that the absorption ratio of NO_3 ions increased as the plant aged, whereas the absorption of the NH_4 ion decreased as the plant aged. It was concluded that a mixture of sulphate of ammonia and potassium nitrate offered the best source of nitrogen to the rice plant.

A study of the water-hyacinth (*Eichhornia crassipes*) was made in Burma and in Bihar and Orissa. It was found that seeds remained dormant from November to June and retained

their viability for several years. A solution of 0·018 per cent. of copper sulphate proved lethal to the plant, but the efficacy of copper sulphate as a destructive agent is adversely affected by the calcium salts liberated from decaying water-hyacinth plants.

A research on the effect of ions on the growth of plants is in progress at the University Laboratories, Lahore. The influence of about fifteen ions including uranium, thorium, manganese, zinc, cerium, copper, has been studied on peas, maize, sorghum, beans, barley, *meth* (*Phaseolus aconitifolius*) and gram. The results definitely establish the preferential activity of thorium, uranium, cerium, manganese and zinc and their accelerating influence on the plant growth, while some of the ions, especially lead and silver, show an adverse effect. In the case of peas which may be taken as an example of the results attained, thorium, uranium and cerium when added in culture solutions as nitrates showed an increase of 23 per cent., 19·4 per cent. and 9·7 per cent. in the average dry weights of the plants at concentrations of 0·0001, 0·00001 and 0·0001 per cent. respectively. Copper nitrate at 0·001 per cent. depressed the growth by 13 per cent. Thorium and uranium also showed an increase of 14·4 and 9·0 per cent. in field plots, but no definite evidence of an increased yield of seed nor of an improvement in the quality of seeds could be obtained.

5. Plant Diseases.

Rice. At PUSA studies on *Sclerotium oryzae* Catt. and a number of other sclerotial fungi isolated from diseased rice plants were continued. It appears likely that there are four species and that there is a physiological specialization and geographical strains. A species of *Cephalosporium* is suspected of causing sterility in rice plants. This fungus is being studied in detail to test its pathogenicity.

In MADRAS the investigations of " blast disease " of paddy caused by *Piricularia oryzae* Cav. were pursued and varietal resistance, response to manurial ingredients, effect of the control of irrigation water and morphological and histological factors

were studied. It was found that the application of heavy doses of nitrogen induces greater susceptibility in plant to disease and that the addition of potash and phosphate exerts slight inhibitory influence. A foot-rot disease of paddy caused by a species of *Fusarium* was also noticed. The disease can be controlled by seed treatment with copper sulphate, two per cent. for thirty minutes or by hot-water treatment. Granosan and ceresan (dry) and uspulun (wet) treatments also gave good results. Varietal resistance study showed that there is a wide range of variation among different varieties in their susceptibility to disease and some were immune.

Tilletia horrida Tak. and *Ustilaginoidea virens* (Cke.) Tak. do a good deal of damage to paddy in BURMA and control measures are being tried.

Wheat. The bunt disease of wheat caused by *Tilletia indica* Mitra was studied at PUSA. This disease appeared in a virulent form in Karnal on many of the wheat varieties grown at the Botanical Sub-Station and the damage was up to twenty per cent. in some cases. Opportunity was taken to make a more detailed observation than has been possible so far, and it was observed that this bunt has also a distinct fishy smell like *T. caries* (DC.) Tub. and *T. foetens* (Berk. and Curt.) Trel. *T. indica* seems to be restricted to the cool regions of the plains like Karnal and other Punjab districts, while the other two are restricted to the cooler hilly tracts.

In PUSA *Helminthosporium tritici-repentis* Died. was studied in detail and the percentage of the leaf-area destroyed by it and *H. sativum* P. K. and B. which also occurs on wheat was determined with a view to estimating the damage done and the varietal resistance. A good deal of variation has been observed in the percentage of attack, not only from plot to plot but also in the same plot.

A survey of wheat rust on all the varieties of wheat grown in the Botanical Area and the Farm at Pusa and all the varieties in the Botanical Sub-Station, Karnal, was made. At Pusa, the orange rust appeared as usual during Christmas and was

first observed on the 29th December, 1932. The yellow and black rusts appeared rather late during 1932-33 and were first observed on the 3rd and 13th February 1933, respectively, as compared with the 16th January and 5th February of the previous year. As in the previous year the attack by all the three rusts was mild during 1932-33, except in the case of Bihar 121 which was rather heavily attacked with orange rust.

At Karnal all the varieties were highly attacked with orange rust and yellow rust was bad. At Pusa there was little yellow rust on Pusa 52, but the same variety was badly attacked at Karnal. The Karnal strain of yellow rust appears to be physiologically different from that at Pusa.

In the PUNJAB wheat seed from a crop showing seven per cent. infection with loose smut caused by *Ustilago tritici* (Pers.) Jens. was soaked in water from three to seven hours and then exposed to the sun from 12 noon to 4 P.M. during June when the maximum temperature was 129·5°F. to 131°F. The crop raised from such treated seeds showed no disease, while control plots showed infection to the extent of 7·1 per cent. This method of treatment of infected seed is a great improvement over the ' hot-water treatment ' as it is simple and safe for the ordinary farmer to carry out without fear of ruining the germination capacity of the seed. It can, however, be carried out only where the sun is hot enough to kill the fungus. Another method tried which gave equally successful results was to expose water to the sun in black painted drums and to place infected seeds in the water from noon till evening after which they are taken out and dried.

The investigation of rusts on wheat carried on at Agra, Simla, Almora, Muktesar and Warkunda under the auspices of the Imperial Council of Agricultural Research was continued. *Berberis vulgaris* raised from seed collected in England has been successfully infected by sporidia of black rust of wheat in this country and wheat and barley were infected by aecidio-spores thus produced. The role of indigenous species of Barberis in a fresh outbreak of black rust is yet under study.

So far four forms of black rust and two of orange rust have been noticed and it appears that the number of physiologic forms of the rust are few in India. The complete absence of the alternate host for orange and black rust in the plains of India is the most helpful feature of the problem as far as measures of control are concerned.

Barley. An estimate of the percentage of leaf-surface rendered ineffective by *Helminthosporium sativum* P. K. and B. and *H. teres* Sacc. was made on various types of barley grown in the Botanical Area, Pusa. The intensity of the disease was found to be less during 1932-33. The percentage of leaf-area destroyed during 1932-33 by *H. teres* ranged from 0·27 to 20·45 as compared with 0·5 to 25·4 during 1931-32, and that by *H. sativum* from 0·22 to 6·78 as compared with 1·2 to 14·2. Seed of twenty-four types of Pusa barley was treated with various fungicides to control the two Helminthosporiums and the data obtained showed that uspulun treatment controls the disease to a certain extent and is more effective than formalin treatment. The experiment to test the comparative resisting power of twenty-four types of Pusa barley to *H. sativum*, together with the effect of uspulun as a seed treatment, was repeated during 1932-33. The efficiency of uspulun to control the disease was again confirmed, that is T. 21 had an average attack of 0·05 per cent. in plots treated with uspulun, and with untreated seed the average was up to 4·72 per cent. That uspulun treatment also checks the attack by smut [*Ustilego hordei* (Pers.) Kell. and Sw.] is illustrated by the following figures. In a plot with T. 21 and treated with uspulun, not a single smutted head was found among 6,650 plants, while out of 7,512 plants grown from the same seed but untreated, the number of smutted plants was 114, giving 1·5 per cent. smut.

The yellow rust, as in wheat, was severe at Karnal as compared with that at Pusa where the attack was mild on the same varieties of barley; only a few varieties escaped infection at Karnal, and here also a different physiological strain seems to play an active part.

Copper acetate and copper carbonate at the rate of one ounce per ten pounds of grain were found to control barley smut in the Punjab.

Sorghum (jowar). In MADRAS ceresan and cattle-urine were tried as seed disinfectants against short smut of *jowar*. Both were effective.

In BOMBAY it has been found that, giving suitable temperature conditions, the infection of *jowar* by grain smut will take place only within a range of soil moistures from forty to seventy per cent., the sixty per cent. moisture being the most suitable for infection. These results thus indicate that, if *jowar* is sown early in the monsoon when there is enough moisture in the soil for the germination of seed but not enough for spores to germinate, the incidence of infection will be low. *Rhizoctonia bataticola* Taub. [*Macrophomina phaseoli* (Maubl.) Ashby] was recorded from sorghum for the first time. The fungus can cause infection of this host when the moisture content of the soil in which the plants are grown is sixty per cent. The disease is assuming considerable importance in the Bombay Presidency, and becomes virulent when late heavy rains appear in November.

The Sclerospora on *jowar* has been redescribed as a new species, *Sclerospora sorghi* (Kulk.) Weston and Uppal. *Sorghum sclerospora* can attack maize and *Euchlaena mexicana*.

Colletotrichum graminicolum (Ces.) Wilson was found to do considerable damage to sorghum in Rawalpindi (PUNJAB). It has been established that the fungus is carried over from year to year by infected seeds. The fungus on the seed is killed by soaking the grain for three hours in water, then putting the soaked seed into hot water at 130-135°F. for fifteen minutes. Experiments carried out during 1932-33 showed that the ' hot-water treatment ' mentioned above can totally check the disease.

In BURMA experiments carried out with sulphur to control grain smut (*Sphacelotheca sorghi* Clinton) gave very good results. Sulphur at the rate of 130·5 grams for every sixty-four pounds of sorghum seed was found to be most effective

and this treatment which is the cheapest is being recommended to the cultivators. During 1932-33 sulphur and ceresan were tried and it was found that ceresan is more effective than sulphur. Ceresan, however, cannot be conveniently handled by cultivators, the cost is much higher than that of sulphur and since the residual infection uncontrollable by sulphur treatment is extremely small, the former cannot be preferred to the latter.

Seed treatment was found to be of no use in controlling *Colletotrichum lineola* Corda which does a good deal of damage to sorghum in Burma. Copper carbonate is reported from the Central Provinces to be more effective in controlling smut disease than sulphur.

Ragi or ***marua*** (*Eleusine coracana*). The diseases of *ragi* caused by species of Helminthosporium was continued at Pusa and in Mysore. At Pusa *H. nodulosum* Berk. and Curt. and *H. leucostylum* Drech. were found to do a good deal of damage. Smut (*Ustilago eleusinis* Kulkarni) and Piricularia sp. were also found to do some damage in Mysore.

Sugarcane. The experiment to test the natural spread of mosaic was repeated in March 1931 at Pusa. A row each of twenty-five varieties alternated with a row of Co. 213 mosaic-infected cane. All the varieties tested were free till the middle of October. At the time of cutting Co. 312 and Co. 313 were found to be infected, the percentage of mosaic being 4·4 and 16·5 respectively. The same experiment was laid down in February 1932, and thirty-four varieties were tested and symptoms of mosaic appeared during April and May on ten varieties, the infection percentage being forty-eight on Co. 313, twenty-two on *Saretha*, seventeen on Co. 210, sixteen on Co. 304 and on the rest ranging from one to seven per cent. This indicates that the vector was more active during the year. During 1933 forty-three varieties were again tested and all remained free from infection.

At PUSA experiments on the effect of mosaic on the yield and juice of sugarcane was continued during 1931-32. Ten

pairs of plots were laid down in adjacent pairs, half of them with mosaic-free and half with mosaic cane in the following order :—Mosaic-free, mosaic, mosaic, mosaic-free and so on. The mean weight of mosaic-free canes was 44·84 maunds and that of mosaic cane was 38·17 maunds, the mean difference being 14·8 per cent. The mean sucrose percentage was 16·27 in mosaic-free and 15·60 in mosaic-infected, the mean difference being 0·67 or four per cent. The samples of all plots were analysed and the data obtained were statistically studied. The difference of weight of cane, weight of juice, brix and sucrose were all found to be statistically significant, but not that of percentage of juice to cane, glucose and purity. The loss in weight of stripped cane was 14·8 per cent., while the quality of the juice had deteriorated. The loss in such conditions, therefore, would be about fifteen per cent. of cane to grower and four per cent. of sucrose to the manufacturer. The experiment was repeated during 1932-33 and it was found that the percentage of juice to cane, the calculated juice to cane and the glucose are alone statistically significant. The weight of cane and the quality of juice had not deteriorated in mosaic plots though there was slightly less glucose. However, four per cent. less juice was extracted from the cane in the mosaic plots.

The tonnage experiments carried out at Taliparamba (MADRAS) with Co. 213 during 1931-32 showed that there was a loss of ten per cent. in tonnage due to mosaic, the percentage of sucrose was apparently reduced, the glucose ratio slightly increased and the brix value was lowered. The experiment was repeated during 1932-33 and the previous year's results were confirmed. It is evident that the diseased setts deteriorate steadily and the cumulative effect of this insidious disease becomes more and more marked year after year.

In varietal resistance experiments carried out at COIMBATORE forty per cent. of Co. 213 took infection in 1932-33 as compared with ninety per cent. in the previous year. Co. 214, Co. 244, Co. 310, Co. 315, Co. 318 and Co. 335 were found highly resistant and Co. 213 and Co. 291 highly susceptible.

Experiments carried out during the last three years at LYALLPUR and GURDASPUR have shown that there is no deterioration either in the yield or quality of *gur* and juice from cane affected with mosaic. It will be noticed that the experiments carried out at Pusa and Madras gave different results.

Evidence that the mosaic-virus may be the filterable invisible stage in the life-history of visible, nonfilterable bacteria has been accumulating at Pusa, where a special staff for research into mosaic and other diseases of sugarcane has been provided by the Imperial Council of Agricultural Research with effect from June, 1932. The dissociation of the virus into visibly cultivable form is being brought about by serial cultivation in alkaline broth. The juice of control healthy plants failed to give growth on similar treatment. The organisms isolated from diseased tissues are pleomorphic giving varying biochemical reactions and capricious in growth, and in the most stable form agree with *B. cereus* in biochemical reactions. A study of the action of virus juice in fresh water algae is in progress.

A peculiar yellowing of canes in the varieties grown at Pusa and in the Saran District of Bihar and Orissa appeared after the heavy rains in July 1931. The leaves began to turn yellow from tip downwards and later on dried up, the mid-rib remaining green for a long time. Reddish streak and spots appeared on the leaf-surface. The withered leaves presented a drooping appearance, and in advanced cases the whole crown drooped and gradually died. The general appearance was that of premature ripening. The lower layers of roots were mostly dead, black with soft cortex, while the surface roots were alive. Red streaks were sometimes seen in cut stems and in advanced cases the pith became discoloured and hollow. The disease appeared again during 1932 in the Pusa and the Sepaya Farms and in many other places. The different fungi isolated from the decaying roots proved to be saprophytic. Application of calcium sulphate, potassium sulphate and uspulun had some effect in the recovery of plants from yellowing. The ' top-rot '

disease caused by *Fusarium moniliforme* Shel. was studied. The disease is caused by the infection of the growing point in the early stages of the growth of the cane. In cases where infection takes place late, the fungus is kept in check, the plants grow normally, and the effect of the fungus is only seen in the shortening of the leaf-blades especially at the ends of the shoots. ' Redstripe ' disease was noticed and the causal organism isolated differed slightly from *Bacellus rubrilineans* and *B. rubrisubalbicans* which are known to cause similar disease in other sugarcane-growing countries. Pathogenicity of this organism has been established and in the top-rot conditions of sugarcane the bacteria has been found to be usually associated with *Fusarium moniliforme*.

A comparative study of three species of Helminthosporium occurring in Cuba and *H. sacchari* Butl. occurring in India was made and the conclusion drawn so far is that *H. sacchari* Butl. and *H. ocellum* Faris are identical though they are different strains and the name *H. sacchari* Butl. with its amplified description (*Trans. Brit. Myc. Soc.* XV, 254, 1931) should be maintained for the ' eye-spot ' disease. Several isolations have been made from various places in India and it appears *H. sacchari* has several strains which differ to a certain extent in cultural characters.

Experiments to control *Striga* (Agya) disease of cane were continued at Tharsa Farm (CENTRAL PROVINCES). In plots on which trash was burnt before cane was planted, there was very little of *Striga* whereas in the control plots *Striga* plants were seen in large numbers. In plots treated with a three per cent. solution of copper sulphate before the setts were planted, the development of *Striga* plants was considerably checked. The efficacy of copper sulphate was tested in several districts and it was found to control the growth of *Striga* plants without affecting the growth of cane.

Cotton. At DHARWAR (BOMBAY PRESIDENCY) it has been established that the wilt disease of cotton is caused by *Fusarium vasinfectum* Atk. The optimum temperature for the growth

of the fungus is 28°C. and the optimum soil temperature for the disease is definitely lower as cotton-wilt is most severe at temperatures ranging from 20° to 27°C. This fact enables the plant-breeder to test his new strains of cotton under conditions of disease of maximum intensity through the adoption of suitable technique which has been worked out. Hitherto these tests had to be conducted under field conditions removed from the optimum for the disease, thus resulting in plants which merely escaped the disease being regarded as disease-resistant. For example, the improved Jayawant cotton has proved highly resistant in the field and has accordingly been introduced in the countryside. But when tested under conditions created by the new technique, it has proved highly susceptible to the disease. Hence it is necessary for the plant-breeder to produce a cotton which combines the good qualities of Jayawant with real resistance to disease. The disease can be carried in the seed. It is unsafe to distribute seed from a field in which wilt has been found. This difficulty, however, could be surmounted by heating the seed to the temperature which kills the fungus but not the germ of the seed.

Investigation on the cotton-wilt has also been pursued in the CENTRAL PROVINCES. Pot experiments have once again shown that the residual effect of the application of sulphur or sodium sulphate applied to wilted land is to inhibit the incidence of wilt. In pots containing wilted soil, treated in 1930-31 with sodium sulphate at the rate of one hundred pounds, fifty pounds and twenty-five pounds per acre, the percentage of wilt was 25·0, 25·0 and 27·7 respectively. In those treated with sulphur at the rate of one hundred pounds, fifty pounds and twenty-five pounds per acre the percentage of wilt was 19·4, 44·4 and 41·6 respectively, whereas in the control untreated pots the percentage of wilt was 91·7.

In the CENTRAL PROVINCES the incidence of the anthracnose disease, caused by *Colletotrichum* sp. in an epidemic form on bolls in 1931 had its sequel in the low percentage of germination and in the heavy mortality of seedlings in 1932 as the seed

was infected. The disease is carried both on the seed and inside the seed; therefore, no seed treatment can be completely effective in securing a wholly healthy crop of seedlings, but seed treatments have been found to be very effective in considerably reducing the infection of seedlings from diseased seeds. Pickling or dusting with uspulun, dusting with copper carbonate and delinting with sulphuric acid have given very satisfactory results. Pickling in a two per cent. solution of copper sulphate has invariably been found to affect germination. Delinting with sulphuric acid cannot be recommended because of the obvious difficulties in the use of this vitriolic acid. Seed treatment for this disease would not be ordinarily necessary unless the seed has been from a crop which has been badly affected by anthracnose.

The incidence of ' seedling blight ' disease was negligible last season because at the time sowing was done climatic conditions were such as to ensure rapid germination, which is the best preventive of this disease. Experiments have been laid out in Nagpur, Akola and Khandwa for the study of this disease.

Grey mildew disease (*Ramularia areola* Atk.) was for the first time observed in the Central Provinces in October 1932. In the affected fields there was considerable defoliation, but it is difficult to say if the defoliation was the result of this disease or of the early cessation of the rains; ordinarily this disease causes no appreciable damage.

In MADRAS the study of the economics of the disease and of the life-history of the fungus causing the seedling blight and boll-rot of *Uppam* (*Gossypium herbaceum*) was continued. The results of the experiments show that the disease can generally be controlled by the following methods :—(1) Selection of seed and exclusive use of healthy seeds, (2) wide spacing in planting, (3) spraying of the crop twice in the seedling stage with Bordeaux mixture and (4) removal of two common weeds in the black cotton soil, *viz.*, *Aristolochia bracteata* and *Hibiscus ficulneus* which serve as alternate hosts of the fungus. The physiological behaviour of the fungus was studied in detail.

The outstanding features of the results of that study are: (1) the saltation phenomenon and (2) the toxicity of the fungus filtrate. The study is in progress and it will be pursued further as it has a bearing on the economic aspect of the problem. An experiment was conducted in pots to study the relation of soil moisture to infection and the results indicate that the amount of soil moisture favourable for infection ranges from thirty-seven-and-half to fifty per cent. Another experiment was conducted on a field scale to study: (1) the effect of dusting the seed with granosan, (2) the effect of time of sowing on the incidence of the disease. As the disease failed to appear, the results were of no value this year.

Cotton 'root-rot' does considerable damage to the cotton crop in wide areas of the Punjab, and a thorough study of it has not yet been made. During the year a grant was received from the Indian Central Cotton Committee, which has enabled the department to employ an Assistant Mycologist to investigate this disease over a period of three years. It is hoped that during this period not only the causal organisms will be determined, but that control measures will be devised which may reduce the loss which occurs annually in a large proportion.

Potato. Spraying against Alternaria disease with half per cent. Bordeaux mixture and calcium arsenate at the rate of one pound in fifty gallons of water gave promising results in MYSORE.

The ring disease of potato which is characterised by sudden wilting of the plant in the field and is due to *Bacteria solanacearum* appeared in a serious form in several parts of Naini Tal District (United Provinces). The disease is transmitted through infected soil and seed-tubers. Long rotation and careful selection of seed are recommended as preventive measures against the disease. Growing of solanaceous crops, that is, potato, tobacco and brinjal should be avoided in the infected fields for at least three years.

Storage of potatoes in underground pits during the summer months was tried at Tamia (Central Provinces) as a demonstra-

tion for local potato-growers. The total loss in weight due to driage and rot was only about nineteen per cent., which cannot be considered to be high. The cost of storing 59 maunds of tubers was Rs. 16-5-6, that is, four annas and five pies per maund. Experiments are in progress to find suitable methods of seed storage during the rains for use as seed for *rabi* sowing.

Experiments to test the varietal resistance of a number of varieties of potatoes against late blight disease caused by *Phytophthora infestans* (Mont.) de B. are being conducted at Upper Shillong Farm (Assam).

Gram. A blight of gram is very serious in parts of the Attock district in the Punjab and is caused by *Phyllosticta rabiei* (Pass.) Trotter along with some other forms which differ in their physiological and pathogenic behaviour. The disease is carried from year to year from dead gram plants lying on old gram fields and near threshing floors. It is also carried by infected seed, and cloudy weather accompanied by rain and strong wind promotes spread of the disease by the dispersal of the spores. It is not carried over in the soil and the fungus does not survive when the diseased plants are buried in the soil. A detailed study of this fungus is in progress. The blight is controlled by Bordeaux mixture and the incidence of the attack is considerably reduced when gram is sown in mixture with wheat or barley, as the latter crop acts as protective barriers which catch the spores and are uninfluenced by it. The cultivators are asked to sow healthy seeds intermixed with barley or wheat and to uproot the crop by hand and burn all plants after threshing.

Another blight of gram of common occurrence in Pusa is caused by *Mystrosporium* sp. Several types of gram have been found to be resistant to its attack and Type 68 has been found to be highly susceptible. The fungus was studied in detail and the disease appears to be seed-borne.

Rhizoctonia bataticola Taub. and *Sclerotium rolfsii* Sacc. do a good deal of damage to gram in Burma and are under study.

Sann-hemp. A wilt disease of sann-hemp has been noticed at Pusa to do damage up to twenty per cent. A strain of *F. vasinfectum* Atk. appears to be the causative agent: in infection experiments, it produced wilt in pigeon-pea but not in cotton.

In Bombay, the fungus has been traced to pods, and in many cases it has been found growing on the end in diseased pods. The seed is thus an important factor in the dissemination of the parasite.

Pigeon-pea. In Pusa the investigation of wilt-resistant type of pigeon-pea was continued and the resistant capacity of T. 80 was again tested during 1931-32 and 1932-33. The results obtained were in conformity with those of previous years and indicate that Type 80 has a high degree of resistance.

A ' leaf-spot ' disease of pigeon-pea is of common occurrence in Pusa and a species of *Cercospora* was isolated and studied in detail. It was found to be a new species hitherto undescribed and the name *C. indica* Singh was given.

Hibiscus sabdariffa (*Patwa*). A stem-rot disease has been doing considerable damage for the past few years at Pusa. *Sclerotinia sclerotiorum* (Lib.) de Bary was isolated and studied in detail. The fungus developed its perfect stage in the culture. For apothecial development an air temperature of below 23°C. seemed to be necessary and this occurs in the last week of December and in January. The appearance of the disease in January, together with the fact that the parasite develops the ascospores stage only in the cold weather, showed that infection is mainly due to these spores. The formation of sclerotia within the seed appears to be an important method of dissemination of the fungus. The disease can be controlled if the sclerotia are turned into the soil when they do not form apothecia, without which the disease cannot be brought about on uninjured tissues.

Tobacco. A ' leaf-spot ' disease caused by *Alternaria* sp. was found to do considerable damage to tobacco in the Rangpur Farm, Bengal, making the leaf unsuitable for cigar wrapping.

The disease first appeared as small straw-coloured spots scattered all over the surface of the leaf, but gradually they increased in size and later on were surrounded by a light brown ring. The disease later on gives the appearance of ' Shot hole '. Another species causing stem-rot was also noticed. The species are being studied in detail at Pusa and were being compared with other species of *Alternaria* known on this host.

A stem-rot disease was also noticed in the Rangpur Farm. The cause was established to be due to *Sclerotinia sclerotiorum* (Lib.) de Bary.

Piper betle. At Pusa the study of three fungi, namely *Phytophthora parasitica* Dast., *Rhizoctonia solani* Kuhn and *Sclerotium rolfsii* Sacc. which cause considerable damage in Bengal, was continued. The three diseases of betel-vine are fairly well distributed throughout India wherever betel-vine is grown. Cultural characters of six strains of Phytophthora isolated from betel-vine from various localities in India were studied and compared with five other known species of Phytophthora. Experiments to control the diseases were repeated in collaboration with the Bengal Department of Agriculture in various places in Bengal and promising results were again obtained with Kerol (0·07 per cent.) as a soil disinfectant to control *Rhizoctonia solani* and *S. rolfsii* and with Bordeaux mixture for controlling the Phytophthora disease. Experiments tried at Pusa with 0·5 and 1·0 per cent. phenyl gave equally good results. Experiments to control disease of betel-vine are being tried in several provinces in addition to Bengal, such as Bombay, Madras, the Central Provinces and Burma. In Bengal the Bhabna variety has been found to be resistant to the disease while the Dhaldoga is highly susceptible.

In Mysore, spraying experiments against mildew gave good results and a species of bacteria which is characterised by black spot on the leaves and vines was observed to be of common occurrence.

Groundnut. A disease caused by *Rhizoctonia bataticola* Taub. is very common in the Central Provinces. The tops of

the main stems or lateral branches turn suddenly brown or black and die, and the affected branch dies from top downwards, ultimately resulting in the death of the whole plant. The disease has been noticed particularly in light soils, and the time of sowing seems to influence its incidence. The small Japan variety is particularly susceptible to this disease which appears to be disseminated by seed. *Rhizoctonia bataticola, Fusarium* sp. and *Penicillium* sp. have been isolated from seeds, the first-named fungus being found in the majority of cases.

Chillies. A disease of chillies commonly named '*Moorda*' is on an increase in different parts of the Central Provinces. It is caused by powdery mildew (*Oidiopsis* sp.). The infected immature and partly opened leaves curl inwards; the infected leaf buds and flower buds fail to develop; diseased mature leaves bear brown dry lesions where the mildew was present. Another symptom of the disease is leaf-fall. Remedial measures by timely spraying are in progress. *Glomerella piperata* (Stonem.) Spauld. and v. Schrenk. has also been known to do a certain amount of damage, but the damage done by it is not so much as that by powdery mildew.

Six strains of *Fusarium* have been isolated at Pusa from wilted plants, but none of them was able to produce wilt in chillies. Attempts to correlate the moisture content of the soil with the incidence of the disease were also not successful. It is suspected that a fungus may not be the real cause of the disease under Pusa conditions.

Coconut. A root disease of coconut palm was under investigation in TRAVANCORE. The only solution of the problem of controlling this disease is by planting resistant varieties especially in areas where conditions strongly favour the spread of the disease and for this purpose seed-nuts have been collected from immune plants and the seedlings raised are planted in gardens which are badly affected.

A wilt disease with symptoms similar to those described for 'Bronze leaf-wilt' was reported from Thamarakulam in South Travancore. The disease developed after a spell of

severe drought and a study of the soil conditions showed that moisture deficiency was the primary cause of the trouble. Watering the affected palms and application of the organic manures were suggested as practical measures for combating the disease and the results obtained were satisfactory.

Coffee. Spraying with vegetable oil mixed with Bordeaux has proved effective in Mysore in completely checking the incidence of black-rot disease.

The Coffee Scientific Officer of the United Planters' Association of South India has under study, at the Mysore Government Coffee Experiment Station, Balehonnur, the leaf rust caused by *Hemileia vastatrix* Berk. and Br. The resisting power of several coffee seedlings produced in the course of the station's coffee-breeding activities are being tested with a view to establishing coffee strains which will breed true for leaf-disease resistance in a relatively short time.

Arecanut. In Mysore fungicides like Bordeaux mixture to which was added gingelly oil, groundnut oil or *kuradi* oil have proved to be efficacious in controlling several disease of arecanut such as 'Koleroga', 'Anaberoga' and 'trunk splitting'.

A wilt like that of coconut palm was noticed in Travancore. Liming and manuring were recommended as remedial measures. The 'Mahali' disease was controlled by covering the tender nuts with a preventive spray of Bordeaux mixture before the onset of the rains.

Tea. Diseases of tea and methods of controlling them are investigated at Tocklai, Assam, by the Indian Tea Association and in Mysore by the United Planters' Association of South India. In South India special attention was paid to 'Black-rot' disease of tea leaf caused by a fungus similar to *Corticium invisum* or *C. theae.* The former is also common in North East India. Brown blight and grey blight of leaf, pink disease of stem and several root diseases were also studied in detail.

Cinchona. A *Phytophthora* sp. causing seedling blight in Mungpoo and Mungsong (Darjeeling Hills) was studied in

detail at Pusa. The organism found responsible for the disease agrees with *Phytophthora palmivora* Butl.

Fruit tree diseases. The diseases of fruit trees are being investigated at Pusa, consequent on a survey of the orchards in British Baluchistan undertaken during 1932-33. A large number of fungi on apple, peach, almond, grape and fig have been recorded for the first time.

A disease of apple seems to be spreading in Mysore and is marked by a dark exudate from the stem, sometimes from cankers. The leaves are affected in early stages and dry up later on. The bark remains healthy, but the heart-wood shows a brown discolouration. Infection probably takes place through broken twigs or through the shimp of the stock remaining after budding has been done. The affected tree dies eventually. A fungus belonging to Agricaceae has been isolated and is being studied in culture.

A soft-rot disease of apple, a root disease of apple, the leaf-blight of pears and the tip-black of mango are under study in the United Provinces and control measures against them are being investigated.

In Burma, the fungal rotting of mangosteens (*Garcinia mangostana*) has been found to be a serious factor limiting the success of consignments of these fruits to the United Kingdom. Different lots of mangosteens from various localities were examined and no organisms were found to decay those freshly picked, but a number of organisms, namely *Diplodia natalensis* Ev., *Pestalozzia* sp., *Penicillium* sp., *Pythium* sp. and bacteria were isolated from those bought in the bazar. Diplodia accounted for the greater number of decayed fruits. Diplodia and Penicillium isolated were found to be capable of attacking fruits through the injured rind. Experiments to prevent infection are in progress.

Miscellaneous. A comparative study of species and strains of Cercospora from various pulses and other hosts was continued at Pusa. Several new species were studied in detail.

In a comparative study of sclerotial diseases from various host plants in progress at Pusa, *S. rolfsii* Sacc. produced its perfect stage and this is the first record of its occurrence in India.

One application of twenty pounds per acre of sulphur made about the time of flowering, that is, forty to forty-five days after sowing, is reported to effect control of powdery mildew of pea in Bombay.

6. Entomology—Insect Pests.

(a) Locusts. As stated in the previous Review, the locust visitation which commenced in 1926 began to wane during the summer of 1931. In July and August 1931, swarms were reported from the South-East Punjab, the North-West of the United Provinces, Rajputana and Baluchistan. From September of that year, the area of distribution increased and from October-December 1931 locusts were only reported from Western Rajputana, Sind, Eastern Baluchistan and the Mekran Coast. Practically no movements of locusts were reported in 1932 except for a few swarms in Bahawalpur, Rajputana and Kathiawar. The solitary phase was found in a number of places during the course of the surveys to which reference is made below. Between October 1933 and February 1934, there were reports of stray swarms in Montgomery District (Punjab), Muttra (United Provinces), Suket (Kotah State), and Katosan (Kathiawar) but no specimens could be obtained. Some increase in multiplication of the solitary phase was noted by the locust survey staff in Rajputana and Sind, but no hoppers of the gregarious type were collected. The comprehensive scheme of locust research financed by the Imperial Council of Agricultural Research was continued with such modifications as the changes in the locust population demanded. As stated in the previous Review, work started in December 1930 with headquarters at Lyallpur. The Punjab Government kindly lent the services of Mr. Afzal Husain (Government Entomologist, Punjab) as Locust Research Entomologist and also

placed the resources of the Entomological Laboratories at Lyallpur at his disposal. For the important Sind-Baluchistan area a Deputy Locust Research Entomologist was appointed and the services of Rao Sahib Ramachandra Rao, Government Entomologist, Madras, obtained on loan. In January 1933, a modified scheme of research was brought into operation as the disappearance of swarms and consequent lack of material had made it impossible to proceed with important parts of the programme. Rao Sahib Ramachandra Rao was appointed Locust Research Entomologist from 1st April 1933 with headquarters at Karachi, on Mr. Afzal Husain's appointment as Principal of the Punjab Agricultural College. A research grant was made to the Punjab Government for the continuation of certain items of locust research at Lyallpur.

In January 1932 a temporary desert-laboratory was established at Pasni on the Mekran coast, to enable detailed ecological and biological studies of the desert locust to be carried out in the midst of what appear to be permanent natural breeding grounds in the sandy areas characterised by a fairly dense xerophytic scrub vegetation, known as *reks*, which occur along the Mekran coast and the valleys parallel to it. Observation posts under the control of the Assistant Locust Research Entomologist at Pasni (Dr. Karandikar) were established at Gwadar, Ormara and a small field station at Ambagh (near Sonmiani) on the Las Bela Coast. In 1932 locust surveys were carried out all over the Indus valley in Sind and the South-West Punjab and in the Las Bela and Mekran hinterland with the aid of a motor-lorry. In addition surveys were carried out with the aid of camels across the Indian Desert in parts of Sind and Rajputana. These led to the discovery of the desert locust in its non-gregarious form in a number of isolated places. In 1933 (and 1934) a more intensive survey was carried out in these parts of South Baluchistan, Sind and Rajputana where the non-gregarious form of the desert locust had been recorded in 1931. The year 1933 was a favourable one in these areas in respect of rainfall and there was evidence

to show that two broods of the non-gregarious type of *Schistocerca gregaria* had developed during the year (one in summer and one in winter) and that the locusts of the solitary phase were capable of making limited migrations. Arrangements were made to start in 1934 two observation posts at typical centres in the Indian Desert, *viz.*, Chachro in the South and Sardarshahr (Bikaner State) in the north.

The ecological work at Pasni includes a study of the effect of temperature, rainfall, humidity and soil moisture conditions on the breeding of the solitary form of *Schistocerca gregaria*, the character and botanical composition of the characteristic vegetation and the effect of the character of the food supply on the development and multiplication of the desert locust. Rainfall at Pasni is practically limited to the spring or early summer and the character and distribution of the rainfall clearly affects the locust population. It was observed in 1933 that in the Pasni '*reks*' there are favoured spots where soil moisture persists much longer than elsewhere and where, in consequence, the scrub vegetation remains green much longer. In such places locust breeding continued until September though it had ceased by June elsewhere, so while two generations of locusts were produced in Pasni between February and June 1933, at least one more is likely to have been raised in these favoured spots. Such spots may serve as concentration points for solitary locusts in times of over-multiplication and thus lead to the transformation to the gregaria phase.

Summary of the work done on the desert locust at Lyalpur during 1931-33.

Anatomy.

With the co-operation of some university students, particularly those of the University of the Punjab, the digestive, respiratory and muscular systems have been studied. The oogenesis and spermatogenesis have also been worked out. A preliminary study of the blood corpuscles of the locust has been made.

One of the features, by which the solitary phase is distinguished from the gregarious phase, is the colour of the eyes. In the gregarious phase the colour of the eye is uniform, while in the solitary phase the eyes are distinctly striped. Histological studies have shown that the pigment cells which separate individual units of the compound eye are more or less devoid of pigment in the unpigmented strides. The physiological significance of this arrangement remains to be studied. It is not unlikely that this 'defective' pigmentation provides the main reason why solitary hoppers do not venture into the bright sunshine of the desert.

A study of the micropylar apparatus has shown that it consists of a ring of elongated funnel-shaped canals just behind the posterior pole of the egg.

Bionomics.

Pairing. Once a pair is in coitus, only very violent disturbances will interrupt it, noises, strong winds, rainfall, the flooding the area, the approach of moving objects or even freezing being ineffective. The loss of both the antennæ in males and females do not interfere in pairing. Polygamy and polyandry are both common.

Oviposition. The chief factor determining the selection of a site for oviposition is the existence of suitable soil moisture conditions. Eggs were never laid in dry soil but as long as moisture is available eggs were laid in any type of soil which could be penetrated by the ovipositor of the female.

The usual number of egg-clusters laid by a female varied from two to four but the best performer in the laboratory laid as many as eleven egg-clusters and the total number of eggs was 853. The average number of eggs per pod was 66 and the highest recorded 120.

It was ascertained that the eggs could be laid at soil temperatures between 20° C. and 42° C.

Incubation period. The influence of temperature and humidity on the incubation period was also studied. Given

suitable soil moisture, the duration of incubation is determined by temperature. At a constant temperature of 20° C. it was 30 days, but at 44° C. which is near the highest vital limit, it was only nine days.

It has been stated that the eggs of the desert locust, kept in dry sand, may remain unhatched for prolonged periods which may even extend to years. In Lyallpur the temperature of the soil rarely remains below the developmental minimum (18° C.) for any considerable time. That being the case, lack of the soil moisture would be the retarding factor in such instances. This very important question could not be studied fully for want of sufficient material. It was found possible through moisture deficiency to prolong the incubation period up to 81 days whilst in the control experiments at the same temperature, the incubation period was only 10 days.

Emergence of larvae from the soil. It was found that neither light nor gravity played any part in this. Hatching took place in a dark room and the larvae worked their way up to the surface of the soil. It was established by actual experiments that hoppers follow the path of least resistance. In the pod in the soil the frothy plug provides the necessary outlet.

Intermediate moult. The view that a dry atmosphere is necessary for the occurrence of the intermediate moult has not stood the test of experiment. Larvae exposed to a fully saturated atmosphere shed the skin normally. Nor was light essential because the skin is shed in perfect darkness.

Colour variation in freshly hatched hoppers. Soon after hatching the first stage hoppers assume the colour which they retain throughout the first stage. In this colour they show variations, and in the same batch all the different types may be present. Some hoppers were green without any pigmentation, others had light markings and the third type consisted of hoppers which were fully-pigmented or black. In a general way the gregarious type of parents yielded black progeny, and the solitary green progeny, and the intermediate type, gave mixed progeny. But this is only generally true, because

from the same female one may obtain a batch of eggs giving green hoppers and then a batch giving mixed hoppers and yet another batch giving pure black hatching.

Longevity of the life of adult. The temperature of the atmosphere plays an important part in the duration of the life-cycle of the locust. At higher temperatures all the life processes are quickened and the life-span shortened. Thus for the brood which appears in spring, the adults being present during summer, the longest life of an adult male in the laboratory was 79 days and that of a female 69 days. On the other hand, adults which acquire wings in September-October, and over winter may live till the following May. The maximum recorded in the laboratory was 236 ± 10 days for the male and 230 ± 10 days for the female. There is little doubt that in nature there are two broods which overlap.

Influence of temperature on the life-cycle. It has been determined that temperature greatly influenced the length of life-cycle. At 24° C. the life-cycle may be 64 days, while at 36° to 40° C. it is only 21 days.

Influence of food on life-cycle. It was found that the quality of food had great influence on the duration of the life-cycle. Of a batch of hoppers bred under identical conditions, those fed on cotton leaves reached the adult stage in 25 to 28 days, those fed on maize did not advance beyond the third instar in that time.

Food. Over three hundred different plants were supplied to the desert locust and of these it refused to feed on about one dozen only.

Outside the vegetable kingdom the locust feeds on its own dead or dying or even moulting comrades, the flesh of animals and even wool. Experiments have been performed to determine the reason why locust eats such a substance as wool, which cannot provide it any nourishment. It has been found that locusts eat wool for the sake of the moisture contained in it, and they refuse to eat dry wool but greedily devour wet wool

particularly when the atmosphere is dry. This emphasises the significance of moist baits.

The amount of food eaten varies with temperature. At higher temperatures the locust eats more per day but within certain limits the total quantity consumed during each instar and hence during the whole life, is greater at low temperature.

Coloration of hoppers. The tremendous variation in coloration that occurs among hoppers bred under different conditions of association, temperature, etc., have been fully described and coloured plates prepared. It has been ascertained that high temperature retards the development of pigment, and hoppers bred at 40° C. were almost white. At low temperature the colour is almost black, that is pigmentation is intensified. In association pigmentation is developed intensely and the hoppers born green turn black. Contrary to this in solitude the black hoppers turn green.

It has been possible to develop in hoppers bred in isolation the black pigmentation of the crowded condition by maintaining an excess of carbon dioxide in the atmosphere. Similarly, isolated hoppers given adequate exercise also developed pigmentation. . The standing locust committee of the Imperial Council of Agricultural Research continued in being and met annually in January to consider progress reports on the research work of the year and to advise on the requirements for Locust research and on the actual research programmes for the coming year. The desert laboratory at Pasni having demonstrated its value, the Governing Body of the Council sanctioned a proposal for some simple and inexpensive buildings. The value of the observations at this station on the western limits of Indian territory increases from year to year and it is highly desirable that it should be maintained until the next locust visitation. A skeleton Locust Bureau was continued and touch maintained with the various reporting agencies and information collected and distributed. The Research Council is indebted to the Imperial Institute of Entomology, London, the Locust Committee of Economic Advisory Council, London, and to a number

of consular officers for information regarding locusts in other countries. It was not found possible to send an Indian representative to the International Locust Conference of 1932, but arrangements were made for the Locust Research Entomologist to attend the Third International Conference held in London in September 1934.

(b) *Other insect pests—Sugarcane.* Intensive studies were made at PUSA of the early stages of the cane borers, especially *Diatraea venosata* Wlk., *D. auricilia* Ddgn. and *Argyria sticticraspis* Hmp.

A series of examinations with the object of ascertaining the incidence of attack by borers and termites were made. About 500 canes of each of the varieties Co. 205, Co. 213, Co. 214, Co. 281, and Co. 303 which had been planted in February 1931 were examined in January 1932, with the following results :—

Variety of sugarcane	Borers per cent.	Termites per cent.
Co. 205	51·2	14·0
Co. 213	41·3	34·04
Co. 214	71·9	14·03
Co. 281	37·3	42·6
Co. 303	41·0	23·7

In canes planted in February 1932, *Scirpophaga nivella* Fb. heavily oviposited on seedlings in the early months of the year. In July, 1,125 egg-masses were obtained from an acreage of 89·68 acres. As a result of systematic collection of the egg-masses throughout the active period of vegetative growth of cane, the attacks of this top-shoot borer were much reduced.

Examination of the plant canes and the ratoon canes in April 1932 revealed that *Emmalocera depressella* Swinh. was present in much larger numbers in the ratoon canes than in the plant canes, being 6·07 per cent. in the plant cane and 17·8 per cent. in the ratoon. Examination of cane stubble left in

the field from the previous year's crop showed that 64·4 per cent. of the stems had cane-borers (*Argyria sticticraspis* Hmp., *Diatreaea* spp. and *Emmalocera depressella Swinh.*) in them.

In the PUNJAB, the study of the relative extent of damage done by cane-borers was continued. At Gurdaspur the 1931 crop showed attacks of borers up to 28 per cent. in Co. 270 and Co. 290, in July, while the lowest attack was 4 per cent. in Co. 285 in September.

The life-cycle of a new Pyralid borer observed for the first time in 1931-32 was worked out, and was found to possess the longest cycle among sugarcane borers (69-84 days). This pest hibernates as a caterpillar in cane stubbles from October to June. Certain varieties of improved canes appear to be much more severely attacked by it than others. In the ratoon crop of Co. 205 the attack by this borer was 22 per cent. to 24 per cent., while it was only 9 to 17 per cent. in Co. 223. The pest was controlled by the removal of the dead hearts, and the introduction of sanitary fluid in the cavity so left. The discovery that sanitary fluid can be used effectively against cane borer is a matter of importance, as previous methods were difficult to apply and expensive, whereas this method is simple and cheap.

In Mysore mass-rearing of *Trichogramma minutum*, an important egg-parasite of various serious moth-borers, was carried on. About 52,800 live parasites were released in a small sugarcane area to control *Argyria sticticraspis* Hmp. A count of the dead hearts was made in this area and in the check. One thousand and two plants were found with dead hearts as against 1,627 in the check area. Work on a more extensive scale will prove the utility of this method of control.

A study of the egg-parasites of *Pyrilla* spp. was continued at Pusa. It was found that the egg-parasites attained their maximum activity in October 1931 (87·5 per cent.). Later, parasitization began to decline and was 20·2 per cent. at the end of December. In January the egg-masses were found under

the sheathing leaves and showed a parasitization of 76·8 per cent. In 1932 the parasitization varied from 84·9 per cent. in September to 95 per cent. at the end of October. In the Punjab a detailed study of the life-history, temperature and humidity requirements, seasonal history, alternative food plants, effect of low temperature and the susceptibility of different varieties of cane was carried out on the sugarcane *Pyrilla*. To combat this pest successfully by collecting with hand nets, it was found that operations should be undertaken immediately after the harvesting of wheat, when the adults begin to migrate to the young canes.

In BURMA the most serious pest of sugarcane is the black Dynastid beetle *Alissonotum impressecolle* in the district of Myitkyina. In 1931 between 14th April when they were first observed and 7th May, more than 560,000 were collected and about 200 acres of ratoon canes had to be abandoned. They appeared again on 12th October, about 4,000 beetles being collected between this date and the end of the month. They feed under cover of the earth by gnawing across bases of shoots, and sometimes also into setts. Both grubs and adults are injurious. Prolonged ratooning is inadvisable. It would be best to plough up all fields every year in the cold weather, *i.e.*, before the beginning of March, and to collect and destroy the grubs present. It is not advisable to go beyond first ratooning. It has been found that very badly affected fields can be cleared and replanted with cane without fear of damage if a period of fallow be observed. The texture of the soil seems to have a great effect on the activity of this pest. In hard heavy clay soils the beetle does not find suitable conditions for breeding.

Rice. In Ganjam, Vizagapatam, and Malabar the rice grass hopper *Hieroglyphus banian* F. did serious damage. The pest had been causing substantial damage to about a tenth of the paddy area in Ganjam district, and it confined its depredations more to low-lying areas (*tamparas*) than level areas. In Vizagapatam the results of controlling the pest by bund-scraping

and egg-destruction were very satisfactory. The area so treated had an increased yield as compared with untreated area, and the farmers were convinced of the efficacy of the control methods and adopted them.

In MADRAS, the paddy stem borer (*Schoenobius incertellus* W.) did marked damage in Tanjore delta, Madura, Anantapur and Salem district. In the Circars the damage was more in the second crop of paddy. The control measures tried at Aduturai, Pattambi, and the Central Farm, Coimbatore, consisted of light-traps, collection of egg-masses, and elimination of dead hearts when transplanting. Light traps gave remarkable results and trapped large numbers of moths together with other harmful insects.

In the PUNJAB light trap trials were carried on against the rice-borer in Dhundi State, Dera Ghazi Khan district, and about a quarter million moths, with as high a percentage of females as 63, were caught; the subsequent damage to late crops in the area under operation was 43·2 per cent. to 66·4 per cent. Further investigations of the efficacy of the light traps in the next crop showed that this pest could not be controlled by this method. It is indicated that the effective method of dealing with the rice-borer problem in that district was clean cultivation, coupled with thorough burning of all rice stubble after harvesting the crop. Late sowing contributes to the intensity of the attack, the early-sown crop showed an attack of 3 per cent. to 5 per cent. whereas the late sown crop was attacked from 21 per cent. to 56 per cent.

In ASSAM this pest occurred in abundance on the Titabar Farm and caused some damage to crops. In Hyderabad State this pest was reported from several places. The use of light traps, ploughing the fields and the collecting and burning of rice stubble were resorted to. In south Travancore the pest caused considerable loss to the cultivators. In Bengal it was found that this pest was bad in transplanted paddy plots where water stagnates. Letting out the water checked the pest.

In BURMA the paddy ear-nibbling caterpillar *Cirphis unipuncta* Haw, caused wide-spread damage in Katha, Bhamo and Myitkyina districts.

In Burma and Assam it is found that the Rice Hispa, *Hispa armigera* lives on wild grasses in the adult stage in the off season and later on spreads to paddy when the crop comes up. It caused damage to *sail* paddy in Sibsagar. It was found that clean cultivation by removing the grasses growing on bunds checked the breeding of this pest. Bagging the adults was also useful.

Cotton. In MADRAS further work on the nature and extent of damage to Cambodia cotton by the two boll-worms, the spotted boll-worm—*Earias fabia*, and the pink boll-worm *Platyedra gossypiella* were carried out at the Central Farm, Coimbatore. The results showed that in the months November-December, there was practically no pink boll-worm infestation which started about the middle of January and gradually rose in severity until by March it reached nearly 20 per cent. In the pickings of January and early February damage due to spotted boll-worm was more in evidence, being twice as great as that caused by the pink boll-worm. As the season advances the damage caused by the latter gradually increases and that due to *E. fabia* becomes steadily less evident. The infestation by *E. fabia* started in December and continued up to March, the attack ranging from 3·2 per cent. to 9 per cent. Among the local cottons the Uppam variety appears to be the least attacked, the maximum damage reaching only 0·9 per cent.; whilst the Karunganni variety suffered much more, the percentage of damage reaching to 6·8 per cent.

In the UNITED PROVINCES research in connection with pink boll-worm and the large-scale field application of the methods of control thus evolved were continued. The area under experimental control was almost doubled exceeding 50,000 acres of cotton. Bionomic and other observations at Cawnpore were continue and provided valuable information. Eighty-five per

cent. of the caterpillars hibernated in the double seeds, and the examination of successive pickings show a marked increase in the number of hibernaculae (double seeds) and in the percentage of live caterpillars as the season progresses. Thus the picking of October 1, 1931, showed 56·3 double seeds per seer and 4·3 per cent. caterpillars, while on 30th November 1931 double seeds numbered 11·82 per seer, with 69·3 per cent. of caterpillars. Observations confirmed the fact that an attack of pink boll-worm had a serious adverse effect on the seed and lint not only of the attacked locks but also on those not themselves attacked. Thus only 70 per cent. of the seeds of untreated origin were sound while in treated areas 90 per cent. were sound. The attack of the pink boll-worm has in addition a marked influence on the oil-content in the seed which was 19·3 per cent. for seed taken from bolls which were all free from insect damage as against 14·7 per cent. for seed taken from an untreated crop. The field control carried out in Hardwar area, Roorkee *tahsil*, showed an increase in yield of *kapas* by about 2 maunds per acre. The total area of heat-treated seed in 1932-33 consisted of 51,750 acres in Aligarh, Saharanpur and Bijnor districts. The methods of control employed were similar to those in previous years and consisted of exposure to the sun, for two hours on a hot day, of all seeds retained by cultivators. Stocks of seeds with merchants were also treated with their consent and 3,835 maunds of seed for cattle feed were sun-treated to destroy the contained boll-worms. The control measures met with better success in Atrauli and Khair *tahsils* of Aligarh due to the whole-hearted co-operation of the bigger dealers in cotton seed, but in Koil and Sikandra Rao *tahsils* some untreated seeds were either retained or imported and subsequently issued to petty merchants from the local market, thus causing a certain amount of re-infection. With this exception and a few other instances a very considerable success of control was effected throughout the area.

The following table summarises the actual field results and demonstrates the effectiveness of the large-scale control

measures adopted in the United Provinces :—

—	Area	Damage to *kapas* in treated area	Damage to *kapas* in untreated area	Average increased yield per acre in treated area	Average increase in the produce of clean *kapas*	Total increased yield in the whole area	Increased total value
	Acres	Per cent.	Per cent.	Md. Sr.	Md. Sr.	Mds.	Rs.
Atrauli area .	30,350	13·8	24·3	2 11	2 30	69,000	5,84,200
Khair *tahsil* .	16,500	16·3	30·3	2 19	2 22	20,000	50,000
Hardwar area	4,900	9·0	32·8	1 0	25 per cent. of total crop.	7,840	63,000

In the PUNJAB, pink boll-worm research work was largely financed by the Indian Central Cotton Committee. The investigations proved that the pest thrives in the South-eastern Punjab and in some other parts of the province but that, speaking generally, the climate of the canal colonies is too hot and dry for it to flourish. It was decided that work should now be concentrated on a more thorough survey of the distribution of this pest in various parts of the province and the correlation of the pink boll-worm incidence with meteorological conditions especially temperature and humidity. A further scheme of work has been approved by the Indian Central Cotton Committee for the continuation of work on both the pink and the spotted boll-worms. Research on the cotton white-fly is also largely financed by the Indian Central Cotton Committee and considerable progress was made in the study of this pest including the life-cycle, seasonal history, effect of variety and manurial treatment on the incidence of attack, parasites and control measures. The work is still in progress, and a special grant was made by the Indian Central Cotton Committee for large-scale spraying experiments at Khanewal, Okara and Lyallpur.

In BURMA the pests appearing on Cambodia, Acala, Broach, Gadag, Wagale and Wagyi cottons were observed and an esti-

mate of the comprative damage to various varieties obtained. The spotted boll-worm bored the shoots in 23 per cent. of the Cambodia plants, 18 per cent. in Acala, 3 per cent. in Broach, 21 per cent. in Gadag, 12 per cent. in Wagale, and 24 per cent. in Wagyi. The damage to buds and bolls by the spotted boll-worm was practically uniform in all varieties. The pink boll-worm was not present in appreciable numbers. *Sylepta derogata* the leaf roller occurred on about 87 per cent. of the plants of Cambodia cotton, 82 per cent. in Acala, 54 per cent. in Wagale and 80 per cent. in Wagyi, the Broach and Gadag varieties being free. *Hibiscus abelmoschus* (Konkado) as a trap crop for the red cotton bug was fairly successful.

Fruit. A preliminary survey of the various insect pests causing serious damage to fruit trees in the Fruit Experimental Station, QUETTA, and other fruit growing areas in Baluchistan was made. The San Jose scale, *Aspidiotus perniciosus* Comst. The black scale *Lachnus persicae* Chaldok, the green scale *Myzus persicae* Sulz., and the beetle *Scolytus rugulosus* Ratz. were found to cause considerable damage to almond, apple, pear, peach, plum and quince trees.

In MADRAS work was done on the citrus fruit moth, and the other pests of citrus fruits and those of figs, and the cultivated varieties of *Zizyphus*. The fig pests were studied in detail and were found to be the leaf-eating caterpillars *Ocinara varians* W., *Hypsa ficus* F. and *Perina nuda* F. A study of their parasites was also made. *O. varians* was attacked by the purpal parasites, *Sualta nigrifrons* and *Goryphus nursei*. Among citrus insects special attention was paid to the bark, and shoot borer caterpillars, the leaf miners and the leaf roller. The fly maggot, *Carpomyia vesuviana* B. and a small reddish caterpillar, *Meridarches scyrodes* M. were found boring the fruits of the cultivated *Zizyphus* plants. The life-histories of these and of their parasites were studied.

In the UNITED PROVINCES the incidence of attack of the apple root-borer and wooly aphis on apple trees in hill orchards at Ramgarh was studied. The apple root-borer kills as many

as 7 per cent. of the apple trees per annum and causes severe injury to many more. This is the most dangerous, if not the most important, pest of the orchard industry. Soil fumigants like carbon bisulphide, and para-dichlorobenzene are being tried, the fumigants being injected, or dibbled, into the soil round the apple trees. The results are awaited.

In the PUNJAB the investigations in progress during 1932-33 covered a wide field, and dealt with the bionomics of Aleyrodidæ on the fig, *jaman*, grape-vine, *falsa*, *ber* and pomegranate. A further detailed study was made of the life-history and control of *Batocera rubra* a serious pest of figs. The observations on the distribution and bionomics of the wooly aphis and walnut weevil borer at Kulu, and a study of the control measures and observations on certain fruit flies in Hoshiarpur district were carried on. San Jose scale was controlled by extensive sprayings in Kulu and Kotagarh. About 8,000 trees, comprising apples, peaches, plums, apricots, and chestnuts were sprayed by departmental staff. The fruit growers of these places were very much satisfied with the efficacy of the spraying and the pest is now well under control. The Imperial Council of Agricultural Research has drawn attention to the necessity of prohibiting the import into other parts of India of nursery stock from the affected areas.

In NAGPUR an appreciable amount of damage was caused to orange trees by the larvae of *Indarbela quadrinotata* and the fruit sucking moths. The former was kept well under control by washing the galleries with kerosine and plugging them with a pad soaked in carbon bisulphide, and afterwards closing them with wet clay. In ASSAM, trunk borers of orange (*Monohamus versteegi*) and shoot borers were reported from several places and studied. They did considerable damage in Garo Hills and Tinsukia, and were controlled by carbon bisulphide injections.

In HYDERABAD the mango hopper was controlled by dusting the trees with sulphur. Three thorough dustings seemed to suffice, the first soon after the emergence of flower heads and

the other two following after intervals of a fortnight. In MYSORE this pest was kept well under control by spraying three times with fish oil resin soap.

Tea. The study of the pests of tea was continued in South India, the chief of them being *Helopeltis antonii*, *Helopeltis theivora*, *Disphinctus humeralis*, a small Tortrix, a large Tortrix, boring beetles (several species of *Xyleborus*) and the nettle grubs (*Thosea cervina*). The crop yields, and soil analysis figures of some gardens in the Travancore State are being studied with a view to determining with what degree of accuracy the extent of damage by *Helopeltis* can be assessed as *Disphinctus humeralis* is so very similar in appearance, and in the nature of its depredations, that it is practically impossible to say which of the two is responsible for the damage. The only distinction noticed in the course of feeding experiments in the laboratory is that *D. humeralis* unlike *H. theivora* leaves the bud and the first leaves practically untouched.

The " Small Tortrix " is of great importance to South India, and is found to be present on tea practically throughout the year and in all the tea districts. The caterpillar attacks the flush and the method of tying up the leaves is very characteristic. It nibbles the leaves first in the form of streaks and later in patches. These patches eventually turn brown and spread all over. The simplest and what appears to be by far the best method of dealing directly with the pest is the systematic hand-picking of the caterpillars. In addition to the removal of shoots normally ready for plucking, all visibly attacked shoots should also be plucked, and this process should be repeated six to eight times at short intervals to free the crop entirely from the pest. If the tea is too young to be hand-plucked and the pest is found very prevalent, it may also be advantageous to pinch the attacked leaves to destroy the caterpillars without removing the leaf. With regard to parasites attacking the pest in its caterpillar stage two small hymenopterus parasites have been bred out so far. They are *Elasmis homonae*, and *Asympiesella indica.*

For the control of the "Large Tortrix", which is less widely distributed in South India than the "Small Tortrix", a biological method of control is being employed. *Trichogramma*, an egg-parasite of Tortrix has been chosen for the purpose and mass-rearing has been started. Two larval parasites are also known; one being a Tachinid fly not yet identified, and the other is an Ichneumonid *Phytodiaetus capuae*.

The nettle grub—*Thosea cervina*—is a serious pest in Ceylon, but it is not considered a regular pest in South India. It breaks out sporadically and large areas may then be stripped of all the leaves on the bush.

Coffee. The coffee borer—*Xylotrechus cuadripes* Chevr.—constitutes the most serious insect pest of coffee in South India. This pest is under investigation by the Entomological Section of the Mysore Department of Agriculture. As there is a March brood of adult beetles in addition to the October brood, it seems desirable that the removal of bored trees should be done in two rounds—one before the March flight and the other in the monsoon. It is highly desirable that grubs and adults should be destroyed by burning before the flight occurs.

The coffee berry borer *Stephanoderes hampei* was found absent in the damaged coffee seeds sent to the Mysore Department for examination by two firms. The attack in all cases appeared to be due to the beetle *Araecerus fasciculatus* which is found in numbers in the estates.

The mealy bug *Pseudococcus citri* R. and cock-chafers are engaging serious attention of the coffee scientific department of the United Planters' Association of South India.

Miscellaneous. Investigations on the preparation of insecticides from fish poisons obtained from the various plants in Mysore were continued. Water extracts with soap of *randia* fruit powder and *hongey* root bark powder were tried against mango hoppers at one pound in ten gallons and one pound in five gallons of water and the percentage of mortality was only 10 per cent. and about 15 per cent. to 20 per cent. respectively.

The following were tested against aphids on cotton, cabbage, cucumber, and on a Euphorbiaceous plant—

(1) *Mundulea subrosa.* Whole plant and root bark powders.

(2) Hongey (*Pongamia glabra*). Stem bark, and root bark powders.

(3) *Randia dumetorum.* Seed powder and fleshy portions of fruits.

(4) *Randias.* Doddakaray, Mugukaray, and Buthikaray. Powder from fleshy portions of fruits.

(5) *Mukhada* (*Lasiosiphon eriocephalus*). Bark powder.

(6) *Sokkinagida* (*Balanites roxburghii*). Bark powder.

Water extracts of the crude powder of the above plants were tested against aphids, and of these *Balanites* bark powder is found to give the best results. *Mundulea subrosa* bark powder comes next and *hongey* root bark the third. In addition to the testing of crude powders, extracts of different parts of the plants with methyl alcohol, chloroform, ether, etc., have been tried and it has been found that these extracts are about ten times as toxic to the insects tried as crude powders. *Hongey* oil converted into soap in the laboratory was found to have as high a toxic property as fish oil resin soap against the green bug of coffee.

Pests of stored grain continued to be studied. In Burma work on pulse beetles was started.

Complete life-histories of the common house cockroach, *Periplaneta americana* Linn., a blood sucking fly, *Tabanus speciosus* Ric. and the " Spider lick " beetle, *Paederus fuscipes* Curt. were studied at Pusa.

7. Useful Insects.

***Lac. Laccifer lacca* Kerr *Tachardia lacca* Kerr.** The Indian Lac Cess Committee, the formation of which was referred to in the last Review, commenced its work from August 1931, when it took over the funds and responsibilities of the Indian Association for Lac Research from August 1931.

Work at the Lac Research Institute at Namkum was continued and developed, more attention being given to problems connected with the utilisation of lac, including both new uses and means of meeting the competition of synthetic substitutes. The publication ' Lac and the Indian Lac Research Institute ' which has recently been issued by the Committee, summarises the activities of the Institute since its foundation. Work on the host trees of lac has been continued and several important results have been obtained. The introduction of *khair* (*Acacia catechu*) as a host of lac in the Chota Nagpur of Bihar has been attended with great success and may be particularly valuable as a rotation for *kusum* (*Schleichera trijuga*) in the production of high-quality lac. Lac brood raised alternately on *khair* and *kusum* appears to gain markedly in vigour. The study of the effect of lac on the host plants has been continued. The effect of fertilizers on the growth of lac hosts and on the yield and quality of lac has also been studied. These experiments are being continued. Present indications are that such manuring, though technically successful, would not be economic whilst shellac prices are low. The rate of secretion of lac on *Butea frondosa* has been studied and it has been found that lac secretion practically ceases four to five weeks before swarming in the case of the *Baisakhi* (dry weather) crop and ten days before swarming in the case of the *Katki* (or rains) crop. This means that the *Baisakhi* crop could be cut a month earlier than customary, which would not only reduce the expense of guarding the crop but would give a better pruning period. Correct methods of pruning have been shown greatly to improve the yield of lac per tree and details have been worked out for the principal hosts, published in popular bulletins, and are demonstrated practically. It has been shown that the ryot's methods of pruning *kusum*, the most important lac host, are uneconomic leading to a diminished ' frame ' and necessitating two years' rest. By the Institute's method full crops can be obtained every eighteen months regularly, and the frame of the tree steadily improved. As in previous years,

entomological research has been directed to an improvement in the efficiency of lac production, both by improvements in cultivating and rearing practices and by the control of the insect enemies of lac which reduce both the yield and quality of the stick-lac. The behaviour of different strains of lac has also been studied from the point of view both of hardiness and resistance to pests and the yield and quality of the lac produced. A simple visual method of forecasting emergence has been worked out. This depends on the appearance of a yellow translucent area on the posterior region of the lac cell prior to swarming. The side and position of this area relative to the three openings of the lac ' test ' (the brachiai and anal tubercular pores) indicate the number of days before swarming is due. The practical importance to the lac-grower of such forecasts lies in the fact that premature cutting results in the weakening and loss of brood lac as well as loss of crop, whilst late cutting means that many of the emerging larvae have been lost before inoculations have been made for the new crop. The scope for improvement is clear from the fact that in some Bihar districts, cutting sometimes takes place a month too early. Temperature has been found to be the most important of the physical factors governing the oviposition of *Laccifer lacca*. Egg-laying ceases below 63° F. in summer and 59° F. in winter and the swarming of the lac larvae is inactive below 68°-72° F. Advantage can be taken of these facts to transport brood lac which is near the swarming stage at an artificially reduced temperature. When swarming is delayed, it can be artificially induced by exposing the brood to a temperature of 75°-85° F. for a limited period or by subjecting it to a low temperature (35°-56° F.) for a short period. The length of the swarming period has been determined for the *Baisakhi* (October-June) and *Katki* (June-November) crops. For the former, it averages six days with a maximum of eleven for individual mother cells; for the latter seven days with a maximum of sixteen. For the crop as a whole, the greater part of the emergences takes place in two weeks, being complete in three weeks. The practical application of

this result is that brood-lac should be removed from the trees after two weeks, or at most three, as after that period it merely encourages insect enemies. The predators of lac are more important pests than the actual parasites, the principal predators being the moths :—

Eublemma amabilis and *Holcocera pulverea* the larvæ of which feed on lac insects on the lac incrustation.

Biological control of these pests has received special attention and eleven beneficial parasites were under study, *viz.*:—

(1) *Microbracon tachardiae* Cam. (*Braconidae*). Host. *E. Amabilis.*

(2) *Microbracon hebetor* Say. (*Braconidae*). Host. *E. Amabilis, E. Scitula, H. pulverea.*

(3) *Pristomerus testaceicollis* Cam. (*Ichneumonidae*). Host. *H. pulverea.*

(4) *Apanteles tachardiae* Cam. (*Braconidae*). Host. *H. pulverea.*

(5) *Aphrastobracon flavipennis* Ashm. (*Braconidae*). Host. *E. Scitula, E. Amabilis.*

(6) *Apanteles fakrulhajiae* Mahd. (*Braconidae*). Host. *H. pulverea* (suspected).

(7) *Bethylid* (*Bethylidae*). Host. *H. pulverea.*

(8) *Brachymeria tachardiae* Cam. (*Chalcidadae*). Host. *H. pulverea, E. Amabilis.*

(9) *Elasmus claripennis* Cam. (*Elasmidae*). Host. *E. Amabilis.*

(10) *Eurytoma palidiscapus* Cam. (*Eurytomidae*). Host. *H. pulverea.*

(11) *Apanteles sp.* (*Braconidae*). Host. *H. pulverea* (suspected).

Both *M. tachardiae* and *M. hebetor* are ecto-parasites of *Eublemma* (the latter also of *Holcocera* and the minor predator *Eublemma Scitula*), and can be artificially bred in the laboratory without difficulty. Eight insect parasites of the lac insect (*Laccifer lacca* Kerr previously *Tachardia lacca*) have been found, *viz.*:—

(1) *Eupelmus tachardiae* How. (*Eupelmidae*).

(2) *Tachardiaephagus tachardiae* How. (*Encyrtidae*).
(3) *Tachardiaephagus somervilli* Mahd. (*Encyrtidae*).
(4) *Parechthrodryinus clavicornis* Cam. (*Encyrtidae*).
(5) *Erencyrtus dewitzi* Mahd. (*Encyrtidae*).
(6) *Coccophagus tschirchii* Mahd. (*Aphelinidae*).
(7) *Marietta javensis* How. (*Aphelinidae*).
(8) *Tetrastichus purpureus* Cam. (*Eulophidae*).

Statistics of the causes of damage to injured lac cells have been collected over a long period. These show that parasitism averages under five per cent., the maximum being under ten per cent., so that special control measures against parasite attack, as distinct from the predator attack, are hardly necessary. Simple measures of controlling the insect pests of lac have been worked out and the following are now recommended :—

(1) Lac intended for use as brood should be cut as near to the time of swarming as possible, never more than one week before for optimum results. The practice of cutting lac for brood several weeks to a month or more before swarming, results in devitalised brood and should be abandoned.

(2) Healthy lac showing the minimum of parasite and predator attack should be selected as brood, enemy-affected sticks should be discarded.

(3) Lac in use as brood should be removed from the trees after a maximum period of three weeks; if the trees are sufficiently covered it should be removed earlier. Two weeks is generally ample for the infection of host trees.

(4) Abandonment of the practice of natural infection (leaving a certain amount of lac on the tree uncut to swarm *in situ*), particularly in October-November. Exceptions to this rule may be necessitated by climatic or other factors, examples being the natural infection of *Butea frondosa*

(*Palas*) in July in the Palamau district, and districts in which the June-July swarming period coincides with the time at which the ryot is planting his own food crops prior to the monsoon.

(The preceding controls 1-4 aim at the production of healthy brood and the reduction of the unavoidable pest emergence from brood lac to a minimum.)

(5) All lac cut from the tree and not required as brood and all brood-lac after use should be scraped from the stick; this action alone destroys a large number of the larvae and pupae of parasites and predators and exposes other to climatic factors and to the attack of ants. While scraping, any enemy larvae or pupae observed should be crushed. As lac practically all finds its way to the markets as scraped lac, the immediate scraping instead of scraping after some delay is all that is implied. This scraped lac also should not be stored in the vicinity of lac-bearing trees. From an entomological point of view the early conversion of scraped lac to seed lac would be beneficial. This control is of particular importance as regards the *Katki* crop lac.

If these simple measures could be systematically applied, the present loss from lac pests would be greatly reduced. The biological control of the principal predators offers considerable prospects of success, provided that suitable methods can be developed on a field scale.

Pests of lac host trees have been further investigated and an important pest of both *kusum* and *ber*—the scale insect *Aspidiotus orientalis* has been studied in detail and the results published. This pest can largely be controlled by timely heavy pruning, with the burning of prunings, lime-sulphur spraying being recommended as a supplementary means of elimination of this important competitor for the lac insect's food-supply.

Chemical and physico-chemical work on lac has been further developed. Methods of improving the country process of shellac manufacture in order to yield high quality shellacs with low wax content have been devised. A method of using the waste-product *-kiri-* in moulding has been worked out and published, and the formulae and working particulars supplied to enquirers. It has been found that the most important factor in determining the quality of shellac made by the country method is the age of the stick-lac (or seed-lac) used and that the time of storage should be reduced to a minimum. Various methods of reconditioning polymerised lac, and shellac, resulting from long storage have been worked out. The controversial question whether additions of orpiment to shellac are ever justified with the object of improving the colour, has been fully investigated. It has been shown that orpiment serves no useful purpose for it improves neither the fluidity, life under heat, elasticity, abrasion resistance of shellac, nor the colour of shellac varnishes. On the other hand, there are many objections to its presence. As orpiment has the effect of raising the iodine value of shellac, the magnitude of this change in this important chemical constant was fully investigated. It was shown that except for some Assam and Burma dark shellacs, the iodine value (*ibijs*) for all pure Indian lacs lay below 15·5. Hence the present accepted maximum of 18·0 is too high since 90 per cent. of the shellacs manufactured would fall below 16 and all below 17. Neither heat-treatment nor age appreciably affected the iodine figure. The effect of orpiment on the iodine value is variable, depending on its distribution in the sample, but $\frac{1}{4}$ per cent. raises the *ibijs* figure by about $1\frac{1}{4}$ to $2\frac{1}{2}$. A method was also worked out for determining the iodine value of adulterated shellac after removal of orpiment, in order to obtain the correct figure for added rosin. The question of standard methods of shellac analysis has assumed a new importance recently, especially in America, where there is a definite movement towards organising the sale of lac productions on the basis of definite chemical specifications. In consequence, considerable

attention has been devoted to methods of determining rosin, wax, acid value, saponification value melting point, life under heat and fluidity. In this matter the co-operation of the appropriate organisations in the United Kingdom, America and other lac-consuming countries is desired. The importance of the iodine value has been referred to above; the Refraction Index has been determined by an accurate method for a wide range of samples and it has been found that all the pure country-made shellacs examined lie within a certain range—this work is still in progress. Another matter of some importance in connection with the selection of types of lac adapted to the special needs of particular industries is the difference in physical and chemical properties of shellacs, seed-lacs and stick-lacs from different sources, in other words, the effect of season, locality and host plants.

The properties investigated include the determinations mentioned above, also wax content, the softening and melting points both of the lac and the extracted wax, colour index, water resistance and ' bleachability '. Data are still being accumulated on this question. Much work has also been in progress in the better utilisation of lac in various industries. Following up the earlier investigations of the physical properties of shellac solutions, the use of new solvents and mixtures of solvents has been studied and also the behaviour of the varnish films resulting from their use. The conditions under which shellac can best be incorporated in drying oils have been determined, as also the relative value as incorporating agents of such subsidiary substances as rosin, glycerol, albertol, ester gum, and sorts of certain metals, *e.g.*, lead potassium, barium, calcium and manganese. These results should be of considerable industrial value. Shellac water and spirit paints have also been studied. A substantial amount of work has also been done on the chemical modifications of shellacs. For example, several shellac esters have been prepared and some of these appear to be of commercial value. A shellac-castor-oil combination was found to give a wide range of plastic materials. Shellac possesses the pro-

perty of thermo-hardening and practical use is made of this in several industrial applications. An important series of investigations was still in progress at the close of the year on the heat-curing of shellac. By the use of various retarding and accelerating agents the time required at atmospheric pressure to convert shellac into an infusible substance can be varied at will from a few seconds to several hours. The retarding effect of increased pressure on the heat-curing of shellac is very definite. For example, a pressure of one ton per square inch inhibited the polymerisation of shellac at 150° C. for $3\frac{1}{2}$ hours, the control sample at atmospheric temperature curing in 75 minutes. This is of practical importance both in the use of shellac in mouldings, where it involves a modification in technical procedure, and in the thermo-plastics and sealing wax industries where a long ' life ' under heat is desired. Work was also in progress in the use of shellac in the moulding plastic industry. At present this field is largely occupied by synthetic products like Bakelite and Beatl, but, if certain difficulties can be got over, shellac should have a wide use in the field. One of these, the low heat deformation temperature of shellac mouldings can now be overcome as a result of the discovery that if shellac, heat-cured at a particular temperature, is rapidly heated to a higher temperature, it can be fused. For example, a moulding power of shellac and wood-flour cured at 110° C. could be moulded at 190° C. and then gave a moulding which did not blister at 130° C. Considerable prominence has been given to this work on the utilisation of shellac, since one great need of the lac industry at present is a wider and more certain market for its products. From August 1931, the Indian Lac Cess Committee took over from the Bihar and Orissa Government the financial responsibility for the special Lac Officer in London. The principal duties of this officer who was appointed in November 1929 were :—

(1) To maintain contact with consumers and ascertain their requirements and their comments and complaints, about the Indian shellac used by them;

(2) To pass such information to the Lac Research Institute and to supply to consumers information received from the Lac Research Institute.

(3) The distribution to consumers of samples of special lacs, and lacs of known history from the experimental factory at the Lac Research Institute; the arrangements for the analyses of such lacs and for reports on their behaviour.

(4) To study the competition between the synthetic resin industry and lac.

(5) To maintain touch with research work on natural lac products outside India and with existing and intended buying specifications.

The Special Officer works under the orders of the High Commissioner for India in London.

Towards the end of 1932, the Committee decided on two further measures designed to establish closer contact between the lac industry in India and the consuming industries in other countries. In the first place, it was decided to appoint three Indian research workers, two with high qualifications in chemistry, and one in physics, for work in English industrial research laboratories. The object was to establish closer touch with the lac-using industries of the United Kingdom and to lay the foundations of a system of scientific and technical ' after-sale service ', for shellac-users comparable with that now offered by the synthetic resin industry. Dr. R. Bhattacharya, M.Sc., Ph.D., A.I.C., A.I.I.Sc., Dr. L. C. Verman, B.Sc. (Eng.), M.Sc., Ph.D., A.M.A.I.E.E., A.M.I.R.E., and Dr. Ali Karim, B.Sc., Ph.D., D.I.C., A.I.C., A.M.I.Chem.E., took up their appointments during the summer of 1933. Thanks to the kind co-operation of the Research Association of British Paint, Colour and Varnish Manufacturers, two of these officers work at the Association's research station at Teddington under Dr. Jordan. In consultation with the British Electrical and Allied Industries Research Association and with the kind co-operation of the British Thomson Houston Electrical Company, the third

officer works in the Company's research laboratory at Rugby under Mr. Bayley Parker. These new industrial contacts promise to be of the highest importance. These officers have been placed under the administrative control of the High Commissioner for India who has appointed a technical committee including commercial, industrial and scientific members, to advise him in lac matters.

The Indian Lac Cess Committee has also made a research grant for a term of years to the Research Board of the United States Shellac Importers Association and entered into reciprocal arrangements with that Association for the interchange of the results of technological and scientific research on lac. There have thus been very substantial developments in research directed to the improvement of the lac industry since 1931.

8. Sericulture.

Apart from the set-back due to the continued universal economic depression, the sericultural industry in India has been experiencing considerable difficulty owing to the dumping of Chinese and Japanese silk yarns in the Indian markets. In view of the menace caused to the indigenous sericultural industry by the increasing imports of raw silk, the Government of India directed the Tariff Board in December 1932 to examine whether the industry had any claim to protection and if so in what form and to what extent the protection should be given. The Tariff Board submitted its report to Government in May 1933, so that the recommendations made by the Board and the action taken by Government thereon fall within the purview of the next Review. The provincial departments and states concerned are assisting in the development of their sericultural industry by extension of the supply of disease-free seeds of various breeds of silkworms and by investigations, relating to improvement of yield of leaves from mulberry lands and introduction of suitable varieties of silkworms suited to particular areas. Efforts are also being made in some provinces and states to introduce improved methods for the reeling and

grading of silk yarns with a view to compete with the products of other countries.

In BENGAL, the Government maintained 12 nurseries and produced 26 tons and 22 tons of disease-free seed-cocoons in 1931 and 1932 respectively, and also raised through the intermediary of trained private rearers 20 tons in 1931 and 22 tons in 1932 of disease-free seed-cocoons, by supplying healthy layings from microscopically examined moths of selected strains for one multiplication. Owing to financial stringency the output of Government nurseries has been reduced and every effort is being made to make up for the shortage by extending the work of the selected rearers trained in the sericultural schools maintained by the department. The total requirement of seed-cocoons for the province is estimated at 90 tons annually, of which 42 tons is now being produced from selected strains of the two yellow indigenous multivoltine breeds of silkworms (Nistari and Chotopoulu) which are continued throughout the year by systematic physiological and microscopical selection in the Government nurseries. Attempts made to introduce exotic superior univoltines have been unsuccessful owing to the high mortality in the worm stage. The rearing of the indigenous white univoltine breed Barapolu (*Bombyx Textora*) is being extended during October-January in different areas. In 1929, the department supplied only 3,000 hibernated, examined layings of this variety but 52,000 cellular layings were sold in 1931 and 75,000 in 1932.

The extension of tree plantations and the improvement of yield of bush mulberry by manuring are two directions in which the department has been able to show a reduced cost of production, and the rearers in many areas have adopted these recommendations. The total number of year-old mulberry plants supplied to rearers of different districts in Bengal for extension of tree mulberries in 1931-32 and 1932-33 was 46,568. The demonstration staff has been also successful in teaching village rearers the need of proper hygienic measures for rearing. In the district of Malda, 2,383 houses have been

improved in the course of 6 years by the rearers themselves by fitting wire-netted doors and windows. In 1931-32, out of 841 cases of epidemic diseases in villages 742 cases were successfully checked, representing a saving of Rs. 30,000 to the rearers; the corresponding figures for 1932-33 were 1,223, 1,090 and Rs. 20,000.

The rearing of *Eri* silkworms has gained much popularity in the district of Bogra and the work has been extended to 24 villages in spite of the present low price, *viz.*, Rs. 1-8 to Rs. 2 per seer, of *Eri* yarn in the local market.

The Berhampore Silk Weaving Institute trains students in improved methods of reeling and several local reelers have undertaken the improvement of their filatures on similar lines. A similar reeling plant has also been installed at the Government nursery at Piasbari in Malda for demonstrations and for training rearers and reelers.

For training the sons of silk rearers eighteen stipends of Rs. 10 per month were granted in 1931-32 and a sum of Rs. 2,950 was distributed to eight passed students for constructing model rearing houses on the departmental plan. In 1932-33 the number of stipends was reduced to twelve and one passed student was granted the reward of Rs. 250.

The Bengal Co-operative Silk Union, Limited, continued to foster the co-operative organisation of silkworm rearers, reelers and weavers.

Agricultural loans amounting to Rs. 7,423 in 1931-32 and Rs. 7,642 in 1932-33 were made to silkworm rearers on the recommendation of the department.

Owing to continued fall in the price of silk and the growing competition of cheap foreign silks in the Indian markets, the area under mulberry in the MYSORE STATE fell from 42,811 acres in 1930 to 36,511 acres in 1931 and rose slightly in 1932 to 36,750 acres. In spite of the adverse trade conditions, the seed-supply, from the six grainages maintained by the State, was increased to 1,440,486 disease-free layings in 1931 and 1,690,505 disease-free layings in 1932 as

compared with 1,217,649 layings in 1930. The total quantity of cross-bred and pure foreign race layings amounted to 740,278 disease-free layings in 1932 as against 565,939 disease-free layings in 1931, and 297,332 disease-free layings in 1930. Owing to the increased demand for layings of cross-bred foreign races, the Government grainages of the Mysore State are taking steps to extend their production. In addition to Government grainages, there were 15 State-aided grainages which supplied 1,642,565 disease-free layings in 1932 and 1,518,641 disease-free layings in 1931 as against 1,241,456 disease-free layings supplied in 1930. The aided grainages earned a bonus of Rs. 7,201 from the Government in 1931 and Rs. 5,963-12-6 in 1932 on the work turned out by them. A seed multiplication campaign was organised in suitable areas and 144,067 disease-free layings were distributed free to 518 selected rearers in 1931 who sold back 250 lakhs of seed-cocoons to the Government grainages, aided grainages and the sericulturists. In 1932, 232,379 disease-free layings were supplied free to 499 selected rearers who sold back 400 lakhs of seed-cocoons.

The Experimental Section at the Channapatna Farm was equipped with necessary laboratory appliances to facilitate research work in silkworm genetics. Experiments relating to the rearing of foreign races of silkworms, crosses between foreign and Mysore races and the pure-line selection of indigenous breeds were continued at this Station as well as investigations of problems relating to improvement of mulberry.

Intensive propaganda in improved methods of rearing in silk-rearing villages was carried on by the staff of the Farm.

Owing to the depression in the trade, financial assistance was given to sericulturists by the grant of loans.

The Government filatures produced 4,436 lbs. of silk in 1931 and 5,930 lbs. in 1932. Owing to lack of demand for waste silk, the department is experimenting on the conversion of silk-waste into spun yarn. Ten more looms and some preparatory machines were added to the Government Silk Weaving

Factory, which produced 21,400 yards of georgette and crepe-de-chine fabrics in 1932. In the Dyeing Section 24,690 yds. of cloth were dyed and finished in addition to 1,300 yds. of cloth belonging to private persons.

In MADRAS, work was continued at the three Government Silk Farms at Coonoor, Hosur and Palmaner on the selection of mulberry and the distribution to rearers of disease-free seeds of selected strains of univoltine hybrids and of the Mysore race. The departmental strains of selected seeds were also multiplied through aided grainages. Mulberry cuttings were distributed free of charge to cultivators for the extension of their mulberry plantations.

The peripatetic rearing party stationed in the Kollegal district instructed rearers in improved methods of rearing and also supervised their work. They also arranged to supply mulberry cuttings and tested, by microscopic examination, the moths of the seeds produced by private rearers. This party tested 199,769 layings in 1931-32 and 200,410 layings in 1932-33. As a result of these demonstrations, the area under mulberry in these centres was extended by 100 acres in 1932. Mulberry plantations were also started in new centres by supply of mulberry cuttings from the Government silk farms.

The rearing of *Eri* silkworms has been successfully demonstrated in a number of areas in the Presidency and in the absence of definite markets for cocoons at remunerative prices, the cocoons are being converted into spun silk for weaving purpose, an improved spinning wheel having been designed by the department for this purpose.

For the improvement of silk-reeling there are two filatures of which one is a steam filature of forty basins and the other a domestic plant of five basins. The department has also been successful in inducing a capitalist to set up a modern silk throwing mill which is turning out good twisted silk and the factory is working at a profit.

In BURMA, the department maintained a central nursery at Maymyo and two sub-nurseries at Mandalay and Paukkaung to

experiment on improvement of indigenous silkworm races and to introduce improved methods of growing mulberry by trials with different kinds of mulberry.

The nursery at Mandalay is maintained to enable the worms to be transferred to a warmer climate in the cold weather. The Paukkaung nursery is intended for developing sericulture in the township and serves as a demonstration centre for training mulberry cultivation, rearing, and reeling, and as a source of seed-supply to the rearers.

The Maymyo nursery received eggs of superior foreign silkworm races and after crossing with the indigenous races distributed disease-free layings to the sub-nurseries, and to the affiliated nursery of the Catholic Mission at Leiktho, in order to extend the supply of healthy layings to the rearers both in the hills and plains. The Maymyo nursery supplied 6,077 layings and 400 seed-cocoons in 1931-32 and 38,123 layings and 875 seed-cocoons in 1932-33. The output of the sub-nurseries is also on the increase. Through the Paukkaung nursery 6,938 layings were distributed among the rearers in the township in 1931-32 and 23,175 layings and 15,100 seed-cocoons in 1932-33. The Leiktho nursery also distributed 2,446 layings and 3,298 seed-cocoons to the rearers in 1931-32 and 8,863 layings and 3,030 seed-cocoons in 1932-33.

In ASSAM, the Sericultural Section of the Industries Department maintained two sericultural stations, one at Titabar and the other at Shillong for the rearing of mulberry, *Eri* and *Muga* silkworms. The station at Shillong reared univoltines, bivoltines and indigenous multivoltine mulberry silkworms and crosses between the foreign and indigenous varieties and supplied seed to the Titabar nursery. The results in the hills were superior and the hill-reared seed when reared at Titabar gave much better result than the same breeds reared throughout in the plains.

The rearing of *Eri* and *Muga* silkworms is being extended by supplying seeds of selected strains to the rearers. In 1931-32, the Titabar nursery obtained 28,122 cocoons from 2,160 layings

of *Muga*, whereas in 1932-33 the yield obtained from 2,608 layings was 40,276 cocoons. In 1931-32, the yield obtained from 294 *Eri* layings was 24,073 cocoons, whereas in 1932-33, 38,226 cocoons were obtained from 264 *Eri* layings. Compared with figures of 1931-32, the production in *Muga* and *Eri* has increased, whilst that of the indigenous multivoltine mulberry race (*Pat*) has decreased to some extent on account of direct supply of univoltine and bivoltine seeds from the Shillong Farm. The univoltine French yellow race weighed 34·1 grms. per 100 empty cocoons in the Shillong Farm in May 1932, when the indigenous Assamese white *Pat* mulberry race weighed 9·44 grms. per 100 empty cocoons in the same crop. The cross between French and Assamese weighed 21·5 grms. per 100 empty cocoons.

Sericultural demonstrations were continued under six demonstrators posted at selected centres, and largely concentrated their efforts among a number of co-operative societies, the members of which are either silk-rearers or weavers or both. In the Surma valley, the demonstrators are popularising *Eri*-rearing and spinning, while in the Assam valley the rearing of mulberry silkworms and the introduction of improved methods of rearing and reeling are the main features of their work.

CHAPTER IV.

AGRICULTURAL ENGINEERING.

1. Hydraulics.

Irrigation being of paramount importance to Indian agriculture, the installation of tube-wells, well-boring, lift-irrigation and the construction of embankments and other minor irrigation works have naturally received considerable attention in most provinces and several Indian States.

The use of large tube-wells, of 10 in. to 12 in. diameter for irrigation purposes is practically confined to the United Provinces, the Punjab and Bihar and Orissa and in these provinces considerable advances have been made. Very substantial progress has been made in the better utilisation of under-ground water supplies.

In the UNITED PROVINCES, 223 tube-wells were installed in the year 1932 in thirty-five of which strainers of 5 in. to 10 in. diameter were fitted and in 188 strainers of $3\frac{3}{8}$ in. diameter. In 1933, 327 projects were completed comprising 47 tube-wells of 5 in. to 10 in. diameter and 280 tubes of the smaller size. Two ten-inch tube-wells installed in the Moradabad district by the Department of Agriculture, United Provinces, were handed over to the Irrigation Department for use in the determination of the economics of tube-well fed canals.

During 1932 in the PUNJAB, 276 tube-wells of various sizes, fitted with stoneware and composition type strainers, were installed. In addition two twelve-inch tube-wells were installed which were fitted with the cadmium-plated, slotted strainers designed by the Agricultural Engineer; from the latter yields of 2·1 cusec and 2·13 cusec respectively under a working head of 10 feet to 12 feet were obtained. In the year 1933, 173 tube-wells of 5 in. and under were installed in the Punjab.

In BIHAR AND ORISSA, there has been a marked improvement in recent years in the demand for tube-wells. In the year 1932,

twenty-nine projects consisting of ten tube-wells of 5 in. to 12 in. diameter and nineteen tubes under 5 in. diameter were completed. In the following year, forty-three installations consisting of eight tube-wells of 5 in. to 12 in. diameter and thirty-five tube-wells of under 5 in. diameter were undertaken. In the majority of these tube-wells the " Sabour " type of strainer, designed by the Agricultural Engineer to suit local conditions, was used. In 1932, the most successful tube gave a yield of 933 gallons per minute from 88 feet of 12 in. " Sabour " strainer. In the following year, a yield of 1,000 gallons per minute with a pumping depression of under 10 feet were obtained from a twelve-inch tube-well. The number of large-sized tube-well installations is still noticeable although there was a remarkable increase in the demand for smaller installations, especially in the hydro-electric-grid areas of the United Provinces and those parts of the Punjab where the advent of cheap electricity has increased the demand for electrified installations for irrigation purposes.

The increase in popularity of tube-wells in the United Provinces and the Punjab is also largely due to liberal *taqavi* allotments to agriculturists for such purposes and the favourable terms under which such installations are carried out.

In the autumn of 1933, the UNITED PROVINCES Government decided to appoint the Ganges Hydro-electric Enquiry Committee to renew the " Hydel " projects and *inter alia* to advise on what action should be taken to meet heavy demands for power for rural development, both in the grid area proper and adjoining areas, which had sprung up during 1931-33. One of the results of the Committee's work was the introduction of a project, which will be carried out by the Hydro-electric Branch of the Irrigation Department, and is expected to be completed in 1937-38; this includes the construction of 1,353 state-owned tube-wells at a cost of about 105 lakhs to command 1,400,000 acres and irrigate annually about 350,000 acres of wheat and 150,000 acres of sugarcane. An interesting part of these operations is the substitution, to the extent of 300 cusecs, of canal water by tube-well water, in the Meerut district and

the utilisation of the water so released in the arid parts of Muttra and Agra districts where, for geological reasons, tube-wells cannot be constructed successfully.

2. Well boring.

In most provinces, the agricultural department maintains a staff for the improvement of village wells by boring. In the UNITED PROVINCES, the number of borings made in the year 1932 was 1,499 and in the following year 1,714, the percentage of successful borings being seventy-one.

In the PUNJAB, 163 borings were made in the year 1932 and 236 in the following year.

In BIHAR AND ORISSA, 218 borings were sunk in 1932 of which 192 were successful, whilst in the year 1933, 157 borings were made of which 118 were successful. These small borings are not classed as successful unless as a result of tests made before and after boring it is shown that the yield of the well has been substantially improved.

There was a heavy demand for boring from the tract lying between the Chota Nagpur Plateau and the alluvial tracts of Shahabad, Gaya and Bhagalpur, where rock is usually met with and also from the hilly tracts of the Orissa and the Chota Nagpur divisions of Bihar and Orissa. Proposals for the purchase of a rock-drilling plant which would enable the possibilities of an underground water-supply in these districts to be investigated, were held up by financial stringency.

In MADRAS, 524 successful borings were made during the year 1932, of which 13 were yielding artesian supplies discharging from 25 to 250 gallons per minute to an average height of 15 feet above ground level. In the following year 652 successful borings were undertaken. An artesian yield of 2,500 gallons per minute to a height of 9½ feet above ground level was obtained from a boring in the South Arcot district. From another boring, an yield of 1,250 gallons per minute at 7½ feet above ground level was obtained.

3. Lift Irrigation and Water-lifts.

The installation of the larger size tube-wells includes the provision of suitable power-pumping plant—small oil-engines being the most common form of prime mover except in districts served by hydro-electric-grid systems.

In BIHAR AND ORISSA, demonstrations of various types of water-lifts were successfully conducted at agricultural exhibitions.

In MADRAS, the Industrial Engineer erected twenty-nine and thirty-nine pumping plants in the years 1931-32 and 1932-33 respectively, thereby bringing under irrigation 300 and 228 acres respectively. During these two years 280 and 274 pumping plants were maintained under the Industrial Department's maintenance scheme, by which the owner of pumping plant obtained the inspection, advice and instructions of the department on payment of a small fee.

In the CENTRAL PROVINCES, seven power-pumping plants were erected in the year 1931-32 and 1932-33.

4. Improved Water-lifts for Bullock-power.

The Persian wheel which in its improved form has now attained a high standard of efficiency and is still within the purchasing capacity of small cultivators, enjoys wide popularity. In the PUNJAB where the competition referred to in the previous Review had given a marked incentive to the construction of metal Persian wheels with improved bearings, the number of improved *rahats* is very substantial.

In BIHAR AND ORISSA, 25 *rahat* lifts were sold by the department. Private enterprise was encouraged and enquiries from those private foundries which manufacture and sell lifts made to patterns supplied by the Agricultural Department, showed that there was a satisfactory demand.

In the CENTRAL PROVINCES, twenty-four *rahat* lifts were erected by the department as against 12 in the previous year.

In BENGAL three types of bullock-driven irrigation pumps for a discharge of 2,000 to 8,000 gallons per hour have been designed.

In MADRAS, improvements have been carried out on the circular *mhote* water-lift and the mechanical efficiency and lifting capacity have been increased considerably.

5. Embankments and Channels.

The irrigation and reclamation of land by means of bunds, embankments, tanks and channels offers considerable scope to the engineering section of agricultural departments, as there are few localities where such schemes are not feasible. Irrigation from tanks, embankments and streams dates back to ancient times and to-day the agriculturist takes a keen interest in such schemes. Most provinces maintain staff for surveying, levelling and designing small projects of this character which, as a rule, are not undertaken by the Irrigation Departments.

In BOMBAY, thirty-two embankment schemes, at an estimated cost of Rs. 22,500 for twenty-four villages in the Bijapur district and thirty schemes costing Rs. 25,720 in Dharwar and Belgaum districts, were prepared. Although in the year 1932-33 there was retrenchment in the staff employed on this work, twenty-seven schemes of a similar nature were surveyed and plans and estimates prepared.

In the PUNJAB, during 1931-32 intensive propaganda in the Hoshiarpur and Jullundur districts was conducted to encourage "wat bunding", the object being the construction of bunds which by preventing rain-water running off the surface soil to the rivers check erosion, improve the soil and eventually raise the water-level. *Wats* were built in at least 50 per cent. of the area in two *tahsils* of the Hoshiarpur district and in 318 villages in Jullundur covering about 100,000 acres. In 1932-33 a great deal of further useful bunding work was done in both these districts.

In BENGAL, several minor irrigation schemes were surveyed and plans and estimates prepared. Two of these projects were

for irrigation of large areas in the Midnapur district. An experiment in the lining of irrigation channels with ' Bitumatic ' is being conducted.

In BIHAR AND ORISSA, considerable progress has been made in this direction and there is a steady demand from cultivators for advice on such irrigation schemes. Eight irrigation schemes commanding an area of over 16,000 acres were surveyed and plans and estimates were prepared and furnished to the owners. In 1932-33 although there was a reduction in the small staff employed on this work, four large irrigation schemes were prepared. Similar work is being undertaken in other provinces.

6. Agricultural Machinery.

The development of small power cane-crushing mills to deal with the increased sugarcane production in areas not served by modern sugar factories has received the attention of the agricultural departments of the cane-growing provinces. With the aid of grants of Rs. 8,000 each from the Imperial Council of Agricultural Research, experiments were conducted in the PUNJAB, UNITED PROVINCES, BIHAR AND ORISSA and BENGAL in the design and testing of small power-driven cane-crushing mills. In the UNITED PROVINCES, BENGAL and BIHAR improved power-driving crushers of suitable capacity have been designed, tested and placed on the market.

In the PUNJAB, an electric drive for small power cane-crushers in the hydro-electric-grid area is receiving particular attention.

In BENGAL, the *gur*-boiler has been re-designed to cheapen construction, reduce the fuel consumption and give an increased out-put. An improved type of power *gur* pug-mill was also designed and tested.

The Agricultural Department, PUNJAB has closely investigated the problem of winnowing the *bhoosa*—grain mixture—and has evolved a machine which has given satisfactory results in the tests carried out. The machine has two main features, *viz.*, a vertical blower of the impeller type producing an air current

with a velocity of 14 miles per hour and a conveyer which carries the *bhoosa*—grain mixture—above the fan and drops it in the form of a continuous curtain. The machine has a capacity of 48 maunds per hour and is driven by an oil-engine of 1½ H.P. Minor alterations and improvements have been effected to the Johnston wooden seed-drill and the machine has been redesigned for construction in metal.

In MADRAS much work has been done in designing ploughs similar to the Hindustani and Meston, suitable for local conditions and within the means of small cultivators. Experiments with the bund-forming implement gave very satisfactory results. Further trials were carried out with the hand power decorticator, chaff-cutter and winnowing machine.

In BOMBAY, a new seed-drill is being given extensive trials. Satisfactory results were obtained on trials carried out with the Howard rotary potato digger on groundnut in soft soils.

In BENGAL progress has been made in improving the *Sobkum* plough for local conditions and a combined plough and cultivator has been designed, and is under construction.

In BIHAR AND ORISSA, the " Bihar " implements consisting of plough, ridger, harrow and cultivator are gaining in popularity and there has been a considerable demand for these implements in North Bihar.

The " Sukhada " set of implements consisting of a three-five-tined cultivator, furrower, and broad-share has been designed for attachment to the ordinary country plough. The implements have been extensively demonstrated in South Bihar and satisfactory results have been obtained; they are of simple construction and can be attached to the ordinary country plough without using bolts and nuts. There has also been a demand for the modified type of Egyptian Norag thresher manufactured by the department.

In MYSORE, further improvements were made and trials were carried out with the new seed-drill for *ragi*.

In the CENTRAL PROVINCES further improvements were effected in the design of the Akola hoe.

7. Mechanical Cultivations.

The year 1933 saw the virtual completion of what is undoubtedly the most extensive sets of experiments on mechanical cultivation undertaken in India, *viz.*, the experiments conducted by the Burmah Shell Company. These were conducted in the Raichur district of the Hyderabad State, Dharwar district of the Bombay Presidency and in the adjoining Jamkhandi State and in the Barrage area in Sind. The results included some further data obtained during 1933-34 and have since been published as a Scientific Monograph by the Imperial Council of Agricultural Research*. In all, the results of ploughing some 6,500 acres using at one time or another tractors have been presented. This work was all carried out under commercial conditions, ploughing being on contract at a fixed rate per acre. Full records, both technical and financial, were maintained and the results are, in consequence, of the greatest value, being presented in sufficient detail to permit of re-calculation to suit other given conditions. Considerations of space prevents anything like an adequate review of the results but the following conclusions have been selected :—

(1) The useful working life of a tractor ceases at the point where expenditure on repairs and spares exceeds a certain proportion of the initial cost. Much depends on the conditions of operation and maintenance but, on the heavy work of weed eradication, a life of 8,000 actual plouging hours is a reasonable estimate—with proper care.

(2) India offers a large and ready field for mechanical cultivation on a contract basis—as a properly organised and supervised commercial undertaking.

(3) Weed and grass eradication offer a most important field for mechanical cultivation. The cost per acre varies with the depth of ploughing required and degree of weed infestation. The draft per bottom

* Mechanical Cultivation in India, by C. P. G. Wade, Imperial Council of Agricultural Research Scientific Monograph No. 9, 1935.

(draw-bar power required) in *hariali*-infested land when ploughing to a depth of 12 in. was 1,829. The fuel consumption of a suitable cater-pillar 30 H. P. kerosene tractor, drawing three plough-bodies cutting 12 in. × 12 in. furrows, is about 5·5 gallon per acre or say Rs. 3-2 per acre. With Diesel tractors the fuel cost is about Rs. 2-10 at this depth. A fleet of six tractors working on weed-infested land ploughing to an average depth of 10 in. could plough at Rs. 12-8 per acre, including all labour, supervision, depreciation and interest as well as fuel stores and repairs. For ploughing to a depth of twelve inches Rs. 15 per acre leaves only a small margin.

It is essential to success that:—

(i) the tractor chosen should be of suitable type and ample power and that the necessary range of implements of suitable size for economic working are obtainable readily;

(ii) work is well planned ahead and definite contracts made to ensure a full working season;

(iii) spare parts for tractors and ploughs are readily available and that the makers' agents guarantee adequate service;

(iv) all repairs are promptly and thoroughly done;

(v) the choice of suitable ploughs receives adequate attention.

The importance of suitable plough-shares is demonstrated by the fact that in the three years 1931-33 the average cost of shares was over Re. 1 per acre but in the following season the cost of this item was reduced to $6\frac{3}{4}$ annas per acre by substituting a suitable type of solid steel share.

Valuable information regarding the re-growth of *hariali* and *kans* grasses was obtained and on the kind of ploughing necessary to secure eradication. Speaking generally, it is suffi-

cient to plough just below the mat of roots so that this is thoroughly inverted and exposed for drying.

Classes for training in the handling of tractors, oil-engines and other agricultural machinery were held in several provinces. The testing of tractors and accumulation of figures of working cost is being continued in the PUNJAB, BOMBAY and PUSA.

8. Electricity in Farming Operations.

In the hydro-electric-grid areas of the UNITED PROVINCES and the PUNJAB, the use of electricity for crushing cane, ginning cotton, grinding corn and similar operations is spreading though the pumping of water is still the most important development.

CHAPTER V.

LIVESTOCK.

1. General remarks.

Although the effects of the general financial depression, referred to in the remarks under this head in the previous biennial Review, were still felt throughout the period 1931-33, yet it must be recorded that a very definite advance was made during these years, largely through the efforts of the Imperial Council of Agricultural Research, to encourage the improvement of India's livestock, the necessity for which has often been commented upon by observers in the past. By the aid of grants from the Council, a number of investigations into some of the many subjects which comprise what is now called Animal Husbandry in progressive agricultural countries were initiated, and there is no doubt that, when a better organisation for the development of this subject in India exists, the money which is now being allotted to it by the Imperial Council of Agricultural Research will bear good fruit, and India may hope to recover some of the vast potential wealth which is locked up in the enormous livestock industry which she possesses.

The period under review culminated in a meeting which was held in New Delhi in February 1933, of the Animal Husbandry Wing of the Board of Agriculture and Animal Husbandry, this being the first meeting of the Board since its reconstitution into two Wings in 1929. As many as 63 members of the Animal Husbandry Wing of the Board attended the meeting, which thus served to bring together representatives from the Central Government, Local Governments, Indian States and non-officials, interested in the different aspects of Animal Husbandry, and provide them for the first time in India with an agenda devoted entirely to that subject. A list of 27 subjects was placed before the meeting for discussion, and most

of these were dealt with in the first place by sub-committees, which were appointed for Veterinary Education, Animal Health, Animal Breeding, Animal Nutrition and Animal Industry including Dairying. One of the most striking papers read at the meeting was that by the Animal Husbandry Expert entitled " The Organisation necessary for the future Development of Animal Husbandry in India " and the addendum thereto prepared by him in collaboration with the Statistician of the Imperial Council of Agricultural Research entitled " An Assessment of the Annual Contribution of Livestock in India to Indian Economy ". In this paper it was shown that comparatively little had been spent on the development of Animal Industry in India compared with what had been done for Plant Industry, though, based on the prices ruling in September 1929, the total cash value of India's animal products, including labour, dairy products, manure, etc., amounts to the enormous sum of more than Rs. 2,000 crores per annum, which is considerably more than the estimated value of her cash crops.

In considering this question of the value of India's livestock, it must not be forgotten that India possesses a much larger number of animals than any other country in the world. The total number of animals enumerated in the 1929-30 census amounted to over 300 millions, excluding pigs and poultry and predominantly cattle, and according to the previous figures it seems that the number is steadily increasing. The next largest animal population is that of 180 millions consisting largely of pigs possessed by the United States of America. To be compared with this is the fact that while the United States of America spends more than Re. 1 per head on the care and development of her animal population, India spends only ½ anna, so that, judging by the success that has attended the provision of more funds for Animal Husbandry work in such countries as the United States of America, Union of South Africa, etc., it is a safe prophecy to make that when India provides a larger amount of money for the development of this work and a proper organisation for its execution, she will be able to produce more with her

present animal population, or conversely to produce the same amount with a less number of animals, and the improvement that this would make in the economic conditions of the country is obvious. As the Royal Commission on Agriculture said in 1927, it is not *more* cattle, but *better* cattle that India requires.

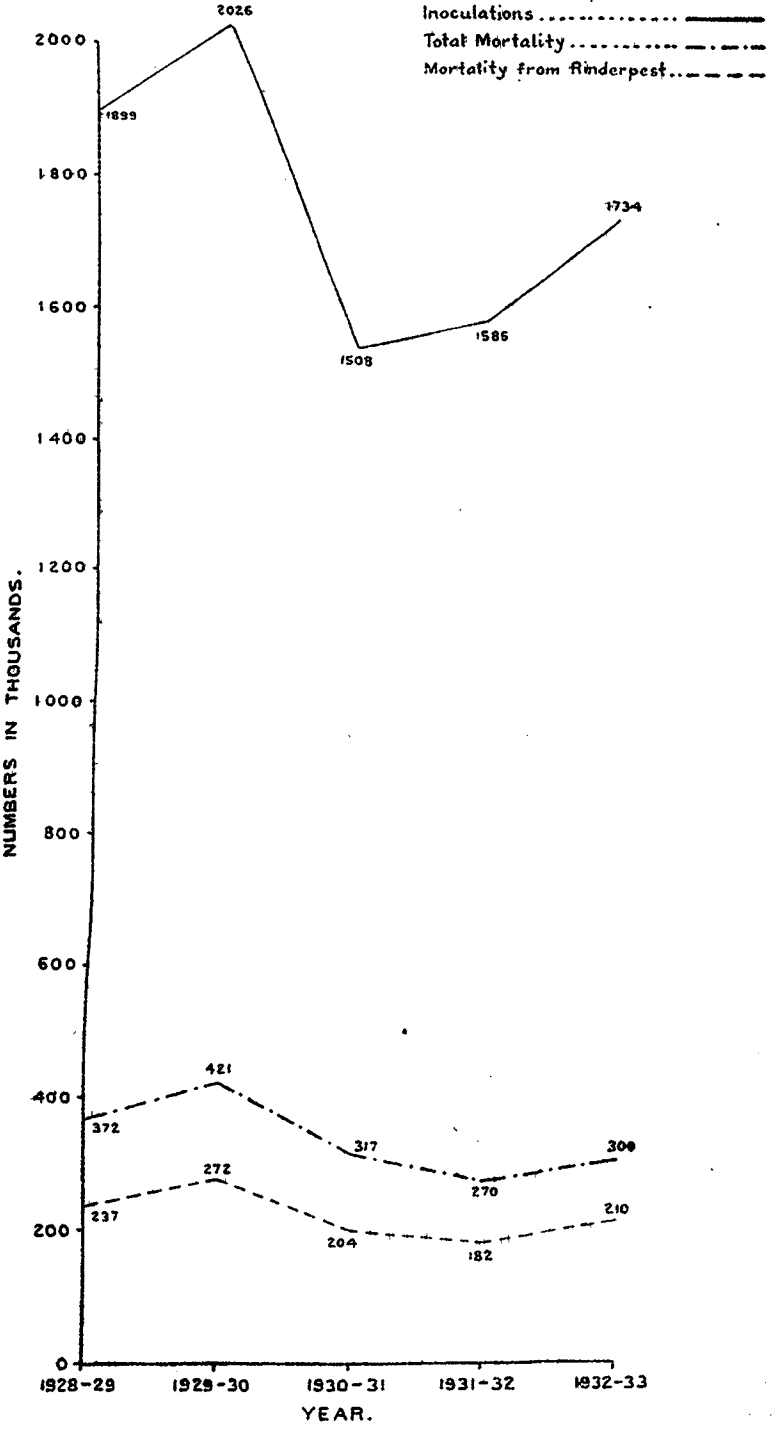
2. Contagious Diseases and their Control.

The following table shows the total reported mortality from contagious diseases amongst cattle in the British provinces of India during the 5 years 1928-1933:—

1928-29	1929-30	1930-31	1931-32	1932-33
371,816	421,178	316,910	270,413	300,317

It will be observed that during the period under review the mortality was noticeably low and considering that there were over 150 millions of cattle in British India at the last census, for which the figures are available, and the small amount of money expended on the Veterinary Services in India, the percentage of mortality from this cause cannot be considered high. The United Provinces hold the unenviable record of returning the largest amount of mortality under this head, *viz.*, over 55,000 cattle each year, and they are closely followed by Madras. On the other hand, there is a very marked progressive improvement in the figures from Madras, where the enormous number of 158,646 cattle are reported to have died from contagious disease in 1929-30. The Punjab figures are very low, amounting to less than 10,000 in 1931-32, but this may be due in part to a different method of collecting them.

The attached graph illustrates very clearly the great influence that rinderpest has on the mortality of cattle in this country, for it is found that during each of the 5 years 1928-33 this disease claimed a percentage of the total reported mortality from contagious diseases varying between the narrow limits of 60 and 70. The term "reported mortality" is used advisedly, for it is admitted that the figures reported, at least


Inoculations
Total Mortality
Mortality from Rinderpest
NUMBERS IN THOUSANDS.
2000
1800
1600
1400
1200
1000
800
600
400
200
0
1899
2026
1508
1585
1734
372
421
317
270
309
237
272
204
182
210
1928-29
1929-30
1930-31
1931-32
1932-33
YEAR.

from some provinces, are not yet very accurate, to which statement confirmation is lent by the fact that during the same 5 years the reported rate of mortality from all contagious diseases in British India, as compared with the total cattle population, is a little more than ·2 per cent. only.

This graph also shows that the efforts of the Civil Veterinary Department to deal with the mortality from these causes by means of preventive inoculations corresponded very closely with the rise and fall in the severity of the outbreaks. The mortality amongst inoculated animals was only ·25 per cent., but unfortunately no figures are at present available to enable any comparison to be made with the percentage mortality amongst uninoculated animals in the same areas.

Although a large amount of research work into the biological products issued from Muktesar was rendered possible by the formation of a Serological Section at that Institute, no change of note was made in field operations during the period under review, except in the case of those products used for the prevention of rinderpest, and here there are definite advances to record. The period commenced with an increase in the demand for the serum-simultaneous method of inoculation, which has proved so successful in Mysore State, where it is stated that 7 lacs of inoculations by this method, conferring a permanent immunity, performed in the 6 years commencing 1926-27, have had a marked effect on the incidence of rinderpest in that state. In Madras these operations were also undertaken on a large scale and that Government decided to open a serum institute of its own and so remove the heavy charges incurred in transporting serum from Muktesar to that part of India. Coincidently with this move on the part of Madras, experiments were initiated in the Central Provinces and Bengal in the use of goat virus alone, for the prevention of rinderpest, and these have proved so very successful that it appears likely that this method will be in general use in India in a few years' time.

3. Local Diseases and Public Health Work.

The following table shows the number of cases of sporadic disease treated at veterinary hospitals and dispensaries and by Veterinary Assistants on tour in British India during the 3 years 1930-33, and it will be observed that a steady increase in these figures is taking place:—

1930-31		1931-32		1932-33	
Hospitals and dispensaries	On tour	Hospitals and dispensaries	On tour	Hospitals and dispensaries	On tour
2,485,389	1,355,877	2,476,802	1,531,214	2,634,406	1,750,311

There has been a comparative lull in the opening of new hospitals and dispensaries, and in some provinces actual retrenchment has taken place owing to financial stringency. The total number at work in March 1933, was 1,038 as compared with 1,012 in 1931. While several provinces quite rightly stress the point that the primary duty of the veterinary staff must be the control of contagious disease, yet the usefulness of a well-managed veterinary hospital in a busy town cannot be disputed. Moreover, it is evident that such an institution is much appreciated by the inhabitants, when, as is reported from two places in Madras, it is able to attract over 5,000 new cases in a year.

Other local activities, in which the veterinary staff is reported to have helped, are the investigation of cases of criminal poisoning and malicious injury, the treatment of cases convicted under the Act for the prevention of cruelty to animals, the inspection of meat, lethal chambers, etc., in municipalities, the removal of brains from suspected rabid dogs, and inspection work under the Glanders and Farcy Act in Calcutta and Bombay.

4. Breeding Operations.

(a) Cattle. Perhaps the most noticeable feature during the period under review in the campaign for the improvement

of cattle is the success which has followed the concentration of work in selected breeding areas in certain provinces, and when this is accompanied by sustained efforts to castrate all the scrub bulls in the same areas, it is to be expected that a general improvement in the local cattle will soon be noticeable, and in certain districts in the Punjab the change is already described as remarkable. In a review of the position by the Government of the Punjab, however, it is pointed out that these operations in special tracts cannot influence the province as a whole, unless the habit spreads, and that the ordinary work of the veterinary staff in every district of a province should include taking a practical interest in the breeding of cattle and all other domestic animals.

The tendency at the present time appears to be towards the establishment of pure-bred herds in all provinces of either locally accepted breeds or, where these do not exist, of the most suitable breeds imported from other provinces, and too much emphasis cannot be laid on the necessity for doing this and so preserving the number of valuable breeds, some of which will provide a good working bullock and others an efficient milch cow, which exist in this country, but which in some cases a few years ago were in danger of extinction. On the other hand, the search for a good dual-purpose animal still continues in some provinces, and in the Hariana breed and one or two others useful material is available, but it is to be hoped that this work will not be pushed so far as to develop one quality at the expense of the other.

In the PUNJAB, the post of Livestock Officer was held in abeyance and the control of breeding operations reverted to Veterinary Divisional Superintendents. The work done in this province may be divided into 3 heads, *viz.* :—grantee farms, special breeding tracts and general breeding work in other districts. The grantee farms are reported to be working satisfactorily and, in those dealing with Sahiwal cattle, cows yielding over 4,000 lbs. in a lactation are reported to be common. Work was continued on the same lines as before in the two

tracts which have been specially treated—the Hariana and the Dhanni. The sale of bulls from the Hissar Cattle Farm, at concession rates, was continued to District Boards, zamindars, etc., and at the end of the period under review the number of approved stud bulls in this province was 4,637. The number of castrations performed during the two years 1931-33 was 913,148—a very large number when compared with a total cattle population of 14 millions only.

The BOMBAY PRESIDENCY has now been divided into what are called intensive breeding zones, which are under the immediate control of the Livestock Expert, and the rest of the Presidency, in which the live-stock work is supervised by Deputy Directors of Agriculture. The premium bull system is stated to be very popular and the demand now exceeds the supply. The young male stock of those bulls already at work is therefore being brought up to prevent early castration and after maturity on Government farms they are re-issued to other parts of the Presidency. A very satisfactory beginning has been made with the introduction of herd-books, which have been prepared for five breeds, *viz.* :—Khilari, Gir, Kankrej, Krishna Valley and Amrat Mahal, but it seems desirable, in the case of those breeds which are also found in adjoining provinces or States, that the co-operation of the other departments concerned should be obtained in formulating breed characteristics, so that there may be uniformity in definition, and only one herd-book for each breed. The number of castrations performed in this Presidency amounted to 66,216 only.

In the CENTRAL PROVINCES, five farms are now maintained and of these three are supplying bulls. The demand for Montgomery bulls from the Telinkheri Farm is stated to be poor but on the other hand the introduction of some *Gaolao* bulls into Chhindwara *tahsil*, a few years ago, has convinced the people that the keeping of pedigree bulls materially improves the village herd and the question of the establishment of controlled breeding areas in this province also is, therefore, being investigated. The number of castrations performed was 227,126.

In ASSAM four farms are at work and at two of them the local animals are being graded up with Scindi bulls, for the production of which pure-bred Scindi herds are maintained. It is stated that the grazing areas of this province are receiving attention and certain areas are now controlled and the castration of scrub bulls enforced. The total number of castrations performed was 38,646.

In BENGAL the policy is still being followed of trying to produce a dual-purpose animal at both the Dacca and Rangpur farms. The premium bull scheme is said to be working well and there is a large waiting list for stud animals. On the other hand, castration is not making much progress, for out of a total cattle population of 25 millions 2,436 animals only were castrated in the two years under review.

In BIHAR AND ORISSA no special livestock officer was available, so this work was carried on in the best way possible by Agricultural Range Officers. Hansi-Hissar herds are maintained at the Sabour and Patna farms and a pure *Sahiwal herd* at Kanke.

In the UNITED PROVINCES attempts are also being made to produce a dual-purpose Hariana animal at the Madhurikund farm, and those cows which give 4,000 lbs. of milk in a lactation are being separated out to form a special herd. The post of Deputy Director-in-Charge, Cattle Breeding Operations, was abolished in 1932 and the officer was placed in charge of a circle but retained control of the 4 cattle breeding farms. The total number of approved stud bulls at work was 3,194 and the number of castrations performed was 90,573.

In MADRAS the Chintaladevi farm for Ongole cattle and the Buffalo Breeding Station at Guntur were abolished as a measure of retrenchment in 1932, and to commence with, the Ongole herd was transferred to Hosur, where herds of Scindi and Kangayam cattle are also maintained. Later, however, owing to a fall in the average yield of the Ongole cows from 12·2 lbs. at Chintaladevi to 9·7 lbs. at Hosur, this herd of

valuable cattle was disbanded. The number of castrations performed in this Presidency was 73,180.

In SIND the Cattle Farm at Malir was closed down in 1932 and a small portion of the herd of Scindi cattle was tranferred to the Fruit Farm at Mirpurkhas while the Tharparkar herd was dispersed entirely. In the NORTH-WEST FRONTIER PROVINCE, which contains only 1 million cattle, the number of castrations performed was 99,834 and the number of approved bulls at stud was 230. A herd of pure Burmese cattle is maintained at the Tatkon Agricultural Station.

(b) Other animals. The declining interest in horse-breeding in this country is evidenced by the fact that during the period under review the decision was reached by the Punjab Government to close down the Arab Pony Breeding Section at the Hissar Cattle Farm. In the Punjab, however, there are still 70 horse and 81 donkey stallions at work, while the United Provinces had 49 horse and 8 donkey stallions and Hyderabad State the comparatively large number of 35 horse stallions on their rolls.

There is not much to report under sheep breeding, but at the Hissar Cattle Farm flocks of Bikanirs and Hissar-Dale sheep were maintained, the rams of the latter being used to improve the local *gaddi* sheep in the Kangra Valley. The Bikanirs are reported to be showing steady improvement and one ram gave 6 lbs. 11 oz. of wool at a single clip. A small flock of Bellary (Deccani) sheep is maintained at Hosur, in the Madras Presidency, with the object of trying to produce a sheep with a pure white fleece. It is stated that sheep of this type, although producing more wool than the black and white sheep, averaged less in body weight and are constitutionally weak. One ram from this flock gave a clip of 6 lbs. 12 oz.

The PUNJAB is also paying attention to goat and camel breeding and, in the case of the former, out of a herd of 60 Jamnaparis maintained at the Hissar Cattle Farm, 4 gave between 600 and 700 lbs. of milk in a single lactation. Goat

breeding with Jamnaparis, Berberis and a few imported Toggenbergs was also in progress at the Etah Mission Station with funds provided by the Imperial Council of Agricultural Research.

(c) Poultry. As a result of the pioneer work of the United Provinces Poultry Association and some of the provincial Agricultural Departments there is distinct evidence that interest in poultry breeding for the production of more and larger eggs, is on the increase in India, and several provinces report expansion of work on this subject. Most of this has been devoted to the introduction and acclimatisation of foreign breeds, and when dealing with a species which matures so quickly as the fowl, the objections that have been raised against the importation of foreign cattle and other large animals do not carry the same weight. Moreover, there appears to be very little difference in susceptibility to the contagious fowl diseases, which exist in India, between imported and native birds. On the other hand, the reactions of the imported bird to differences in climate and diet are severe, and it is reported from the Punjab that prolonged trials have shown that imported birds noticeably deteriorate in egg-production, body size, size of egg, fertility, hatchability and viability of offspring, unless new blood on the male side is introduced periodically. The necessity for grading up the country breeds or evolving satisfactory fixed types by judicious cross-breeding is therefore obvious.

Work on the former subject was continued at Gurdaspur, in the PUNJAB, and it has already been shown that whereas the mean annual production of eggs from unselected birds is only 34·8, that of birds of the selected type is 81·6. Work with several foreign breeds was also undertaken and it was found that the Black Minorca and White Leghorn proved to be the best egg-layers. Considerable trouble is reported at the Gurdaspur Farm from Doyle's (Ranikhet) disease and other undiagnosed conditions in the young birds. In BENGAL work was commenced to evolve a satisfactory cross between the Rhode Island Red and Chittagong breeds of fowls, but unfortunately the

very promising results obtained were nullified by a severe outbreak of Doyle's disease. A selected flock of country birds was also maintained and in these the average number of eggs laid increased from 66 to 80 per annum. From ASSAM it is reported that the White Leghorn has been found superior to the Light Sussex, which has now been discarded. In BOMBAY efforts were concentrated on the supply of stud birds of superior breeds, for which there is stated to be a growing demand. In MADRAS, six different breeds were investigated at the Hosur Cattle Farm, and it was found that White Leghorns were the most prolific but that Black Minorcas laid the largest eggs. English breeds of fowls were also introduced into the North-West Frontier Province but here also Doyle's disease appeared and the experiments had to be abandoned.

5. Dairying.

The central organisation for the development of the dairy industry in this country suffered very considerably from the need for retrenchment during the period under review, and both the Central Research Creamery at Anand and the Central Bureau which was attached to the Imperial Dairy Expert's office, were closed down.

At the BANGALORE Institute, which now maintains two pure-bred herds of Scindi and Gir cattle, work on the economic rearing of Indian breeds of calves by weaning and hand-feeding was continued and this Institute also undertook an investigation into the comparative efficiency of different pasteurising machines. From the pure herd of Sahiwal cattle maintained at the Imperial Institute of Agricultural Research, Pusa, outstanding advances are reported as a result of a system of handling and pre-milking the cows sometime before calving and of milking four or more times a day, which has been introduced. The yield per cow per day has been raised to 17·9 lbs. and it is stated that an increase of 47 per cent. in the total milk yield of the herd has been obtained. From the Karnal Farm, where

breeding work with Hariana and Tharparkar cattle is in progress, it is reported that there has been a steady improvement in milk yield and records of over 8,000 lbs. per lactation have been obtained in both herds. Even of more interest is the report that Indian cows can yield a fat percentage of 7·8, and instances of animals in these herds giving a fat percentage of 6·5 are stated to be quite common.

The dairy attached to the Imperial Institute of Veterinary Research, MUKTESAR, showed a great improvement during the period under review, the average daily milk yield per cow rising from 8·15 lbs. to 14·6 lbs. and one half-bred Holstein-Scindi cow, in her fourth lactation, gave 10,009 lbs. in 293 days, with a maximum daily yield of 44 lbs.

In BENGAL the Scindi herd at Dacca is stated to be milking well; first class heifers yielding as much as 20 lbs. of milk per day, but the animals are losing bone and size. On the other hand, imported Murrah buffaloes show no sign of deterioration and some of them have yielded 5,000 lbs. in a lactation, as compared with 1,500 lbs. from local buffaloes. From ASSAM it is reported that eight Scindi lactations averaged only 2,320 lbs. but this is a considerable improvement on the local Assamese cows, the average of 30 of which was only 1,055 lbs. In BIHAR AND ORISSA the Sahiwal herd at Kanke gave an average of 12·9 lb. per cow per day, and from the Dairy attached to the Patna Veterinary College, where an attempt is being made to improve the *Desi* cow by crossing them with Tharparkar bulls, an average of 8·7 lbs. was obtained. A herd of Murrah buffaloes is maintained at SEPAYA and it is stated that there is a great demand for these bulls' services. A herd of pure-bred Scindi cows is also maintained at the Agricultural College Farm, MANDALAY.

From MADRAS an interesting account is given of the Ayrshire cross-breds with Scindi and Sahiwal cows, which have shown a progressive deterioration in milk yield, the first 3 generations giving a daily average of 15·5, 13·4, and 11·9 lbs. respectively.

A mixed herd of 33 cows, with a varying proportion of imported blood, is maintained at the dairy attached to the Coimbatore Agricultural College, and the daily average yield of these cows was over 15 lbs. One cow gave 11,534 lbs. in a lactation, with a daily average of nearly 30 lbs.

The Milk Recording Station at the HISSAR CATTLE FARM has now tested 725 herd cows since its inception. Of these 94 completed their lactation in 1932 and the results are tabulated below :—

No. of cows	Milk yield during their lactation
53	1,000 lbs. or over.
28	2,000 „ „
7	3,000 „ „
5	4,000 „ „
1	6,000 „ „

Interest in buffalo-breeding for the production of bulls of known milking ancestry, is also on the increase, and, in addition to those provinces already mentioned, successful work is reported from the PUNJAB, MADRAS, and the UNITED PROVINCES Another feature of the development of dairying in this country is the formation of co-operative milk societies. These have been in existence for many years in Calcutta, but new ones are reported from ASSAM and from Agra and Jhansi in the UNITED PROVINCES.

CHAPTER VI.

VETERINARY AND ANIMAL HUSBANDRY RESEARCH.

1. Animal Health.

As foreshadowed in the last review, a very definite advance took place in the period now under review in regard to the prevention of rinderpest amongst cattle in this country. As the result of research work originally commenced at Muktesar in 1927 and the pioneer efforts in the field of the Directors of Veterinary Services of Bengal, the Central Provinces, Bihar and Orissa and Hyderabad State, aided by the Disease Investigation Officers supplied by the Imperial Council of Agricultural Research, a simple, cheap and effective method of protecting cattle with an adapted goat virus alone has now been introduced, and there seems to be no reason to doubt that, when suitable arrangements can be made for the preparation and transport of the virus on a large scale, this method will be adopted by all provinces and States as their routine method of prevention, in preference to the "serum alone" or "serum-simultaneous" methods, which have previously been followed. In addition to its successful application to mature country cattle, it has been found quite safe to use on cross-bred calves up to the age of 18 months, and after preliminary experiments on the calves of the Muktesar Institute Dairy it was extended to Military Dairy Farms and the Imperial Cattle Farm, Karnal.

Another important advance made during the period under review was the finding of the parasite responsible for the condition known as nasal granuloma or snoring disease of cattle. The first observation of a schistosome worm in material from these cases appears to have been made at the Muktesar Institute on 23rd December 1931, but within a very short time reports were received that the same parasite had been seen by workers in the laboratories attached to the Veterinary Colleges at Patna, Madras and Lahore. At Madras a further advance was made

in the elucidation of the complete life-history of the worm by the production of the disease in healthy cattle through cercaria obtained from certain snails.

Other helminthological conditions which were worked out at Muktesar during the years under review were a form of liver cirrhosis in horses, giving rise to a persistent debility, which was also found to be due to a schistosome worm; the well-known condition of Bursati in horses, in which the already incriminated habronema worm was confirmed as the cause; and the life-history of the Indian cattle fluke, *Fasciola gigantica.* In connection with the condition set up by the latter parasite the United Provinces report very good results in its treatment with both Danistol and carbon tetrachloride. The latter drug is much cheaper, but its use has to be carefully supervised, and even then some fatalities may be expected owing to its toxic properties.

In order to help field workers to recognise the worms which are responsible for the many parasitological conditions existing in this country, Scientific Monograph No. 6 of the Imperial Council of Agricultural Research entitled " The Helminth Parasites of the Domesticated Animals in India " was prepared at Muktesar and sent to the press, and this has since been distributed.

The condition of surra has attracted a good deal of attention both at Muktesar and in the provinces, with the result that the public may now feel assured that it is a disease which can be successfully cured with the preparation known as Naganol or Bayer 205 used by the comparatively simple method of intravenous injection. This method has been in use in the field on a large scale in the Punjab for some time past, and recent work at Muktesar, carried out under controlled conditions, has proved that the intravenous injection of this drug will effect a permanent cure in both horses and cattle. Similar reports are also made from the United Provinces, Madras and Burma, but from the Central Provinces it is reported that horses affected with surra were destroyed under the Glanders and Farcy Act.

In Burma the important observation has been made that ·24 grams of Naganol per 100 lb. body-weight will protect a horse for 42 days against a natural infection with surra.

Other protozoal conditions which were under study during the period of review were theileriasis of cattle at Muktesar and piroplasmosis of dogs due to *B. gibsoni* infection at Muktesar and Madras. It now appears that the parasite responsible for the fatal form of theileriasis, so frequently met with in imported cattle in this country, is either identical with or very similar to *Th. annulata*, which has not been recorded previously in India, and unfortunately no successful form of treatment has yet been devised for it. Experiments to transmit *B. gibsoni* by means of the tick *Rhipicephalus sanguineus* were initiated but not completed at Muktesar, but very favourable results on the treatment of this condition with Novarsenobillon are reported from Madras.

Material received at Muktesar from the provinces indicates that tuberculosis is on the increase amongst domestic animals in India, and, apart from its known prevalence in cattle, records of its occurrence in such unusual hosts as the buffalo, elephant and camel were received from Bombay, Madras and Sind respectively.

Anthrax was another common disease of animals for which suitable protective agents were sought and a spore vaccine, made by the Burma Veterinary Department, is said to have given very good results in elephants, cattle and horses. The " Carbozoo " vaccine, which is used in Europe, was tried out at Muktesar and found to be very efficient, but its use in India is not advocated, owing to the alarming symptoms it sets up. The claim made in previous years by Assam that natural anthrax in cattle can be cured by intravenous injections of arsenic was not confirmed during experimental work on artificially infected cases at Muktesar.

Turning to those conditions whose cause is thought to lie in some nutritional disturbance, we find that *Kumri* was under investigation at Muktesar, Patna, and Rangoon, but there is no

notable advance in our knowledge to record. On the other hand the blindness in calves of north-west India, which has been under investigation for some years at Muktesar, is said to have responded at once to the addition of cod-liver oil and green food to the diet. It is also suggested that some cases of equine abortion, both in Burma and in certain studs in north India, may be ascribed to a defective diet, although in those studs from which *B. abortus equi* has been recovered, the use of the improved Muktesar vaccine is said to have given very promising results. Osteoporosis in horses was under study in Rangoon and the first record of osteomalacia in cattle in India was made from Hyderabad-Deccan.

Poultry diseases, especially that popularly known as Ranikhet or Doyle's disease, also engaged the attention of Muktesar and Madras, and the latter place reports that a vaccine has been prepared and that it has successfully stood its first test.

From Bengal the report is made that haematuria of cattle is causing great loss in the Darjeeling Hills and material from these cases was under study at Muktesar, but there is nothing positive to report.

In the realm of Veterinary Entomology, Muktesar reports that, with a view to expand the work on the warble fly pest of hides and skins, an application for funds for a special staff was made to the Imperial Council of Agricultural Research, and this has since been sanctioned.

2. Animal Nutrition.

As a result of work done in the Aminal Nutrition Section at BANGALORE it has been found that the amount of silage previously fed to milch cattle can be materially reduced without causing a loss in milk yield. Two groups of cows were tested, one group consuming 29·2 lbs. of fresh silage per head per day, while the other received only 17·2 lbs., the deficiency being made up with the less costly *ragi* straw, and the milk yields remained equal.

Various Indian coarse fodders were tested for digestibility, and it was shown that the digestibility of several ingredients in

a fodder decreases as maturity advances or when it is converted into hay.

The effect of supplementing a fodder ration with a mineral is being tested, both with growing animals and adult bullocks, and an important observation which has been made is that a mineral supplement has no effect in cases where enough is present in the fodders themselves. The object of another investigation was to determine the comparative values of the mineral composition of grasses grown on selected soils in different parts of India. It has been observed that the protein content is a specific character, but the mineral content varies in the same variety grown at different places. Another observation made was that the mineral content varies with the stage of maturity, the dead ripe stage being of very poor quality. The feeding of a mineral supplement has now become a routine in most parts of India where live-stock are maintained for production purposes and it is reported from the Central Provinces that the Agricultural Chemist has manufactured a mineral brick with these substances, which can be fed as a cattle " lick ".

Several silage-making experiments were in progress at Bangalore, and that with *juar* has shown that the prime stage produces the best silage with the least loss, that it is more profitable to ensile the straw rather than to feed it in the raw state, and that the immature plant is quite unsuitable for ensilage. On the other hand, digestibility trials carried out at LYALLPUR with *juar* showed that this fodder, whether fed green, as hay, or as silage, is not a maintenance diet as regards its nitrogen balance. The same result was obtained with several grass hays taken from different parts of the province, and with wheat *bhoosa*, gram *bhoosa*, Sudan grass, Napier grass and Guinea grass. From Bengal, however, it is reported that, using local cattle, an increase in weight took place when feeding Guinea grass and that Napier grass proved a border line maintenance ration, but paddy straw and water-hyacinth failed to do so.

In MADRAS work has been commenced on the analysis and feeding of 50 species of important South Indian grasses to

determine their usefulness as cattle fodders. Chief of these is the grass known as *kolakattai* (*Pennisetum cenchroides*), which already has a great reputation in Coimbatore district, and it is considered that its use might be widened.

Some interesting experiments are reported from the provinces in connection with ensilage. At LYALLPUR wheat *bhoosa* was mixed with a green rougage and left in a *kutcha* pit for 9 months. At the end of this time, the mixture was of a good colour and aroma and the *bhoosa* had absorbed most of the plant juices which would otherwise have been lost and the *bhoosa* itself was, therefore, rendered more digestible. From Bengal it is reported that silage made of paddy straw and water-hyacinth and from *juar* and water-hyacinth turned out well and was well relished by the animals, but reference has already been made to the poor feeding qualities of these fodders. In Madras experiments were made in those parts where hill grass is abundant after the south-west monsoon, in mixing this with *Juar* and cow-gram in a silo pit, and the results appear to have been very successful.

3. Animal Genetics.

In a country like India, which maintains over 200 million cattle besides other animals, and in which the inhabitants are so dependent on live-stock for their existence, it is a remarkable fact that the science of animal genetics, comparatively new though it is, has so far attracted so little notice as to provide only one item for record under this head. It may be held by some that it is unnecessary, therefore, to make use of this heading, but no survey of animal husbandry research would be complete without reference to this fundamental science, and it is felt that the mere mention of it may possibly excite interest in it and stimulate effort, which will result in a gradual increase in our knowledge regarding the factors necessary for the successful breeding of animals in this country, where the conditions and requirements are of such a wide range. During the years 1931-33, the only investigational work, which can be classified

under this head, was the trial of some different hormone preparations for stimulating sexual activity in both male and female cattle, which was carried out in Bengal and at the Central Institutes at Bangalore and Muktesar with varying results.

CHAPTER VII.

VETERINARY EDUCATION AND OTHER COURSES.

1. Veterinary Colleges.

The arrangements for veterinary education in this country still remained incomplete to this extent that no provision was made for advanced training in Veterinary Science, suitable to equip young Indians for direct appointment to the superior provincial Veterinary Services, which have been created to take the place of the Indian Veterinary Service, recruitment to which was stopped many years ago.

The proposal of the Royal Commission on Agriculture, that one of the existing veterinary colleges should be rendered suitable to teach up to the required standard, was discussed at length, but it was finally decided to shelve the proposal for the time being, on the score of expense, and advise young Indians, desirous of entering the higher veterinary services, to proceed to Europe and obtain the Membership of the Royal College of Veterinary Surgeons, England, or other equivalent diploma.

This decision having been reluctantly agreed to, the way was paved to devise a uniform curriculum for the existing veterinary colleges, where courses of 3 or 4 years are in force, for the purpose of training graduates for appointment to the subordinate veterinary services, and this subject was, therefore, submitted to an expert Committee of the Animal Husbandry Wing of the Board of Agriculture, for this purpose. The terms of reference to the Committee were to devise a curriculum for a 3 years' course, which was done, but a good deal of discussion took place in the Board meeting on the question whether the standard course for Veterinary Assistants should be fixed at 3 or 4 years. Finally, the Committee's curriculum was adopted, with minor alterations, but it was recommended that the course at the Lahore Veterinary College should remain at four years, and that other colleges should work up to this standard when finances permit.

The desirability of having one standard of education for all graduates entering the subordiate veterinary services of India is unquestioned, but there appear to be certain difficulties, mainly financial, in the way of attaining this ideal, and present indications are that there is a good deal of variation in the methods and standards of teaching at the different colleges, with consequent differences in the value of the graduates turned out.

PUNJAB VETERINARY COLLEGE. The four years' course leading to the diploma of Licensed Veterinary Practitioner was continued, but there was a marked falling off in the number of candidates seeking admission to this College. In 1931 there were 38 candidates of whom 20 were admitted, while in 1932 only 19 sought admission and of these 10 were admitted. This, no doubt, was due in part to the fact that the chances of obtaining Government employment were not good during this period, and of the 81 students who graduated during the two years under review it is stated that a few were still unemployed in 1933.

BOMBAY VETERINARY COLLEGE. The three years' course was continued, and although 27 new students were admitted to Class A in 1931 and 26 in 1932, the number of students on the rolls fell from 121 at the commencement of the period under review to 99 at the end. Altogether 48 students graduated from this College during the two years 1931-32 and it is stated that 11 are still unemployed.

MADRAS VETERINARY COLLEGE. The period of training remained at three years as before, but owing to the introduction in 1930 of a revised curriculum, very similar to that since approved by the Animal Husbandry Wing of the Board of Agriculture, the students were taught under two systems during the two years under review. By 1st July 1932, however, the revised course had been introduced in all classes, so that most of the students who graduated as members of this College in March 1933 had the benefit of the new curriculum throughout their training, and in this connection it is of interest to observe that

the Board of Examiners recorded their opinion that the general standard of knowledge shown by these graduates was definitely higher than in previous years.

In spite of the fact that, as a measure of retrenchment, the number of scholarships at this College was reduced to four in 1932 and that all other students had to pay a tuition fee of at least Rs. 90 per annum, the number of admissions rose from 40 in 1931 to 42 in 1932. In all 61 students graduated in the period under review, but information in regard to their employment is not available.

BENGAL VETERINARY COLLEGE. It is reported that the demands for admission to this College have been on the increase in recent years, with the result that the classes are very crowded and the Board of Examiners have pointed out that, owing to the extra strain thrown on the teaching staff, the general standard of knowledge in the larger classes is lower than it used to be. As many as 88 new students were admitted in 1931 and 61 in 1932, while the number who graduated during these two years amounted to 56. It is stated that there is a demand for the graduates of this College from Indian States and other bodies, but no precise information on this point is available.

PATNA VETERINARY COLLEGE. It is reported that owing to the general economic depression and dearth of vacancies in the department, the number of youths seeking admission to this College was not as high as expected. In 1931, twenty-one new students were admitted, but in 1932 the number fell to ten. Altogether 23 students obtained the diploma of this College during the two years 1931-33, after completing their three years' course of training.

INSEIN VETERINARY COLLEGE. This teaching institution, except for short post-graduate courses, remained closed throughout the period under review.

2. Indian Dairy Diploma.

Courses leading up to this Diploma, each extending to two years, are held at the Imperial Institute of Dairying, Bangalore, and at the Allahabad Agricultural Institute. Of the 24

students who were admitted to the Bangalore course in 1929, twenty passed the final examination held in December 1931. Another batch of 19 students commenced their studies in October 1931, and their work was spread over the dairy farms at Karnal, Wellington and Bangalore.

An examination was also held at Allahabad in December 1932 and of the 10 students, who sat for the examination, 8 passed.

3. Post-graduate Courses.

The three months' post-graduate course in Veterinary Science, which is held annually at the Muktesar Institute, was well supported during the two years under review, 10 officers attending it in 1931, and 8 in 1932. In addition a number of officers each year spent a short time at this Institute to receive short courses of practical instruction.

A post-graduate refresher course was held for the first time at the Patna Veterinary College in 1932. Seven graduates attended the course, which lasted from 1st July to 23rd December 1932.

No refresher courses were held at the Veterinary Colleges in Madras, Bombay and Calcutta during the years 1931-32, but a six weeks' course in the vernacular was arranged and attended by 14 Veterinary Assistants at the Lahore Veterinary College in 1932.

A fifteen months' post-graduate course in animal husbandry and dairying was held at Bangalore during the period under review. Three students completed this course in 1932 and one more was admitted to it in February 1933. A number of post-graduate students and British soldiers also attended short courses of training in dairying at the Bangalore, Wellington and Karnal Farms.

CHAPTER VIII.

DISTRICT WORK.

The effect of financial stringency and retrenchment operations has been severely felt by the district staffs of provincial agricultural departments. While in 1930-31, the total number of officers in the Superior, Provincial and Subordinate Grades of the agricultural departments in British India, engaged on district work, was 55, 109 and 1,629 respectively, the corresponding numbers in 1932-33 were 4999 and 1,369 only. As a result of this reduction in man-power and shortage of funds the departments have had to curtail their district activities to an appreciable extent.

1. Demonstrations.

MADRAS. The system, which was started in 1930-31, of concentrating the work of each demonstrator at a few selected centres, was continued during the period. The number of demonstration plots worked by the department totalled 2,132 in 1931-32 and 2,733 in 1932-33; and these plots were mainly confined to the centres of work and the demonstrations related chiefly to specific items of improvement on the principal crops. The Director remarks that though the progress achieved so far might not be commensurate with the energy and time spent at each centre, there could be no gainsaying the fact that the output of work was considerable in regard to certain items of propaganda, as for example, in the endeavour to increase the manure supply of the cultivator and in the demonstration of efficient methods of ploughing. Personal contacts were constantly reviewed between the ryot and the demonstrator and, with a view to a better understanding of the economic position of the ryot, village surveys were undertaken in some circles. In a review of the working of the present system of demonstration, the Director observes that the time has now come when this intensive demonstration work should be extended to three or four centres instead of being confined to one at present. This

will be possible if each demonstrator is given eight demonstration *maistries* (or *kamdars*), with whose help the demonstrator can carry on his intensive work in 40 villages at a time. After two or three years of work at one centre a fresh batch of 40 villages might be taken up. This system, it is said, will be more effective in bringing home to the cultivators over a wider area the agricultural improvements advocated by the department.

BOMBAY. The number of demonstrations of tested agricultural improvements given on the cultivators' own land was 1,660 and 1,637 in the two years under review as against 1,610 in 1930-31. The demonstrations consisted as usual in popularising improved crops and cultural methods, seed-grading, fodder-conservation, fruit-farming, green-manuring, land-development and campaigns against pests and diseases. The ' mass propaganda scheme ' started in 1929-30 was continued in Ahmednagar, Sholapur and Poona districts. Mention may be made of the dry-farming demonstration carried out at Ahmednagar, where 800 acres were under improved methods of farming, thirty demonstrations were conducted by the demonstration staff and about 100 meetings were held by the local school teachers whose help was secured for the occasion. The demonstrations were in all attended by 4,000 cultivators and the demonstrated increase in yield due to improved methods was 58 per cent. of grain and 37 per cent. straw.

BENGAL. The practical demonstrations conducted by the department numbered 2,167 in 1931-32 and 2,709 in 1932-33, as against 2,861 in 1930-31. The most promising feature was the increasing number of private farms, of which there were over 215 in 1931-32 as compared with 165 in 1930-31. These farms, which grew departmental seed and were run on modern lines, formed a most valuable link between the Government farms and the cultivators. An important item of propaganda work during the period was in connection with the restriction of the area under jute, and a novel method adopted was the distribution, all over the jute-growing districts, by an aeroplane chartered

free from the Bengal Chamber of Commerce, of over eight lakhs of leaflets advising the cultivators to grow less jute. Sugarcane was recommended as a substitute money-crop for jute and many more demonstrations were given on sugarcane-growing and *gur*-making. Mention is made of one such demonstration conducted in Mymensingh which attracted the notice of thousands of cultivators and led to a considerable increase of cane-growing in the locality.

UNITED PROVINCES. The number of private farms which are worked under the supervision and advice of the department increased from 1,118 in 1930-31 to 1,307 in 1931-32 and again to 1,332 in 1932-33. These farms, in addition to functioning as principal centres for the multiplication of improved seed, served as powerful demonstration centres in their neighbourhood. The practical demonstrations of improved crops, implements and green-manuring totalled 17,060 in 1931-32 and 29,960 in 1932-33, as against 18,846 in 1930-31. The area affected by the demonstration was 408,406 acres in 1931-32 and 192,542 in 1932-33, as against 373,204 acres in 1930-31. The apparent reduction in 1932-33 has arisen from a more exact definition of what should be regarded as a field demonstration.

PUNJAB. As a result of retrenchment the number of agricultural assistants and *mukaddams* engaged in district work has been reduced from 70 and 155 in 1930-31 to 58 and 116, respectively, during the period under review, and this curtailed the district work to an appreciable extent. The number of demonstration plots laid down by the touring staff of the department totalled 2,380 and 2,199 in the two years under review as compared with 2,336 in 1930-31. Special mention is made of the plots laid down in the Lyallpur Circle, where the average increase in favour of the demonstration plot amounted to half a maund per acre in the case of cotton and 2 maunds 17 seers in the case of wheat, as compared with the local varieties.

The system of concentrated work with a view to the conversion of whole villages to the use of the improved methods was continued and 452 villages received concentrated attention.

BURMA. The number of demonstrations conducted in the cultivators' own fields totalled 1,790 in 1931-32 and 1,590 in 1932-33, as compared with 1,182 in 1930-31. The concentrated demonstration work in the Myingyan Circle which was started in 1931 with the help of a grant from the Indian Central Cotton Committee was continued. Improved methods in the layout of land, drill-sowing, intercultivation, winter-ploughing, preservation and utilisation of farm waste as manure, etc., were demonstrated on forty-nine and sixty-nine holdings, respectively, in the two years under review. In the more successful of these holdings, the yield of cotton averaged over 700 lbs. of seed cotton to the acre, the average local yield being only 196 lbs. The demonstrations are reported to have borne fruit already, and over 200 cultivators have started laying out their holdings on improved lines.

BIHAR AND ORISSA. The number of trained *kamdars* employed by the department for demonstration work has been reduced from 106 in 1930-31 to 96 in 1931-32 and again to 80 in 1932-33. In addition, the Co-operative Banks and the Wards Estates employed 42 *kamdars* in 1931-32, but next year some of the Banks dispensed with the services of their *kamdars* as a measure of economy. The total number of field demonstrations carried out was 8,976 in 1931-32 and 9,358 in 1932-33 as against 8,061 in 1930-31,— a perceptible increase despite the reduction in staff. Mention should be made of a unique experiment in farming on improved lines, conducted on an area of 315 acres at Byreah, with the co-operation of the Bettiah Court of Wards Estate. The chief crops grown were sugarcane, wheat, oats and pulses and during the last four seasons of its existence, the farm has given handsome returns on its capital and recurring expenses in spite of the fact that it carried out a number of field-experiments. In 1932-33, notwithstanding the low prices realised for the produce, the gross profits amounted to 18·8 per cent. of the total expenditure including the cost of establishment. The results achieved on this farm have been embodied in a departmental bulletin.

CENTRAL PROVINCES. The total number of demonstrations carried out by the district staff was 4,485 in 1931-32 and 4,709 in 1932-33 as compared with 4,200 in 1930-31. In addition to these a number of demonstration plots were worked, some by the department on rented land and others by the cultivators themselves on their own land under the direct supervision of the department. Over and above these, a certain number of special irrigation plots were laid down in the Eastern Circle in order to demonstrate the value of irrigation for rice cultivation, either alone or combined with improved seed and better methods of cultivation. The number of such plots was 26 and 32, respectively, in the two years under review. Of the 32 plots worked in 1932-33, 20 were under the Kharung and 12 under the Maniari reservoir. In the heavy soil area under the Maniari reservoir, irrigation alone gave an increased yield of 140 lbs. per acre, whilst irrigation combined with improved seed increased the yield by 235 lbs. In the area commanded by the Kharung reservoir where the soil is of a lighter description, transplantation was also demonstrated. The increases in yield due to irrigation alone, irrigation combined with improved seed, and irrigation combined with improved seed and transplantation were 395 lbs., 185 lbs. and 471 lbs. per acre, respectively.

ASSAM. The practical demonstrations carried out by the department totalled 2,885 in 1931-32 and 3,169 in 1932-33 as compared with 1,953 in 1930-31. Demonstrations with improved varieties of rice alone totalled 1,409 and 1,519 in the two years under review.

SIND. The *kamdars* of the department and of the Taluka Development Associations conducted 369 and 261 demonstrations on the cultivators' own fields in the two years under review. An attempt has been made to re-organise the demonstration work and to adapt it more closely to the actual local requirements. Programmes were drawn up in advance and submitted to the local committees of the Provincial Board of Agriculture for consideration, and suggestions were also invited from District Collectors. The scheme for the establishment

of six auxiliary farms in the Barrage areas for purposes of demonstration and supply of seed and implements has been put into operation and the farms have begun to function as effective demonstration centres. In addition, a definite programme of propaganda and demonstration for the introduction of improved varieties of cotton and better methods of cotton cultivation into the Barrage areas is being carried out with the help of a grant from the Indian Central Cotton Committee and has met with considerable success.

NORTH-WEST FRONTIER PROVINCE. In this province district work has been started for the first time with the help of a small staff of 12 *kamdars*. Fifty-six demonstration plots were laid out in the districts with improved varieties of crops, methods of cultivation and manures. In addition, a number of demonstrations with improved implements were held in zamindars' lands.

HYDERABAD. In this State 698 and 967 practical demonstrations were carried out in the two years under review. In addition, a system of 'aided farms' has been started under which some selected cultivators' farms are used as more or less permanent places of demonstration. Four such farms were worked in 1932-33, and three more were approved for 1933-34.

MYSORE. A special feature was the expansion of the district activities in the Irwin Canal area, where a vigorous campaign was made for the extension of sugarcane cultivation. Nearly 3,000 acres have been planted almost all with the same variety of cane and manured on uniform lines.

2. Other Forms of Propaganda.

MADRAS. The three motor units maintained by the department continued their itinerary throughout the Presidency, except the Nilgiris, spending about four months in each circle. Officers of other departments accompanied the vans in their jurisdiction and co-operated in the propaganda work.

BENGAL. Wireless talks on agriculture given by departmental officers in Calcutta in 1932-33 were an interesting feature of propaganda. These talks which drew attention to some

of the important lines along which attempt is being made to improve and develop agriculture in the province were appreciated both by the press and the public.

UNITED PROVINCES. Steps were taken to provide each circle with two effective magic lanterns, with slides on agricultural subjects, and arrangements will be made for extensive village-to-village tours. Two films have been prepared—one on sugarcane cultivation and the other on modern methods of converting organic waste into composts. Arrangements are being made with the railways for the erection of kiosks in the main stations to illustrate departmental activities, and negotiations are also in progress for the display of posters and notifications giving particulars as to where information about agricultural matters can be most readily secured.

PUNJAB. The scheme referred to in the previous review of reserving one rectangle in each of 20 villages in the *Nili Bar* for allotment in half-rectangle-grants for three years to those cultivators who farm their holdings best in the year, was continued and 40 rectangles have already been awarded up to 1932. The scheme promises to be a great stimulus to better farming.

Another effective method of advertising the advantage of scientific methods of agriculture adopted was the grant of two squares of land to each of 38 agricultural assistants of the department, who had been retrenched owing to financial stringency, and also to four other graduates of the Agricultural College. These land grants which are scattered all over the province will undoubtedly prove a most fruitful method of propaganda for the department.

BIHAR AND ORISSA. An excellent start has been made in South Bihar with a " better farming campaign " and improved methods of sugarcane cultivation were extended to 12 new villages in 1931-32 and 135 villages in 1932-33.

CENTRAL PROVINCES. A number of demonstrations continued to be given with the departmental cinema-lorry and it is reckoned that no less than two lakhs of people have attended these demonstrations in the Western Circle alone.

SIND. With a view to intensifying the propaganda work in the Barrage areas a touring propaganda party was organised, which equipped with a portable magic lantern and slides illustrating the work of the Agricultural Department and small exhibits of improved seeds, etc., visited 36 centres in the first year and 133 centres in 1932-33 and gave illustrated lectures. The party also assisted at several local agricultural shows and large demonstrations arranged by the district staff. In an endeavour to popularise the improved varieties of wheat, a wheat-growing competition was organised in 1931-32 and prizes were awarded for the best areas under departmental strains of wheat offered for the competition.

3. Agricultural Exhibitions.

MADRAS. All suitable occasions, such as District Conferences, Health and Baby Week celebrations in urban areas, and fairs, festivals and *jamabandi* camps in the rural areas, continued to be utilized for arranging exhibitions. There were in all 150 such exhibitions in 1931-32 and 168 in 1932-33.

BOMBAY. The number of shows held in the two years was 166 and 98, respectively. In the first year three big shows were held in the Deccan. Mention may be made of the one organised at Mandrup in Sholapur district which was in imitation of the presidency agricultural show on a small scale, and was attended by all leading cultivators of the district numbering over 10,000. Of the big shows held next year may be mentioned the one at Pandharpur which was organised by the Village Improvement Committee of Sholapur and lasted 10 days. It consisted of special sections of agriculture, machinery, field-produce, crop-courts, land-development, etc., and was attended by three lakhs of cultivators.

BENGAL. Twenty-seven and 31 exhibitions and fairs were held in the two years under review and the department participated in most of them by sending exhibits and delivering lantern lectures. Among the successful exhibitions may be mentioned those held at Suri, Howrah, Basirhat and Faridpur.

PUNJAB. The agricultural stall at Lyallpur continued to be an important centre for the selling of departmental seed and implements, and has become a valuable link between the department and the commercial community. The stall was visited by 12,600 persons in 1931-32 and 10,541 in 1932-33. A number of successful Farmers' Weeks were organized in the various circles, when the district staff induced as many cultivators as possible to visit the headquarters' farms. Among the successful weeks may be mentioned those held at Jullundur, Rawalpindi and Gurdaspur which were attended by 5,851, 1,600 and 11,000 people, respectively.

BIHAR AND ORISSA. Eighteen and 20 shows, respectively, were held in the two years under review, in many of which the department took an active part.

BURMA. A dozen shows were held in each of the two years. The Pagoda festivals in the Minbu and Magwe districts offered good opportunities for the staging of departmental exhibits and similar use was also made of the five-day and seven-day bazars in other districts.

MYSORE. The Annual Dasara Exhibition in Mysore continued to be utilized by the department for the staging of exhibits and for conducting demonstrations.

4. Agricultural Associations.

MADRAS. A number of agricultural associations interested themselves in staging agricultural and industrial exhibitions and also stocked agricultural machinery for sale and loan purposes. The one at Trichinopoly is reported to have expanded its work by starting branch associations in rural parts. The Plantain Growers' Section of this Association sent a representative to North India to study the market for bananas. Four new associations were started during the period and a scheme was drawn up for the revival of a defunct one.

BOMBAY. The number of Taluka Development Associations which functioned during the period was 68, and of these 23 and 28 associations have been classed as having been very efficient

in 1932 and 1933, respectively. Many of these continued to be helped by Government contributions, but the formation of new associations could not be encouraged owing to financial stringency. The Deccan Agricultural Association continued to take an interest in rural-uplift work.

BENGAL. In spite of the discontinuance of Government contributions to district associations, many of the associations in the Western Circle are reported to have done good work. One association in the Northern Circle functioned successfully and also expanded its work, but the associations in the Eastern Circle are reported to be in a moribund state.

UNITED PROVINCES. In the Eastern and Central (Sarda) Circles a number of Village and Better-farming Societies carried on agricultural propaganda and also maintained seed-stores. The Better Farming Societies in Fatehpur numbered 29, and their propaganda covered an area of 2,000 acres. In Fyzabad, propaganda was concentrated in a compact area of 50 villages with the help of the better-farming societies. A Village-Uplift Committee has been formed in the Unao district and six villages have been selected for propaganda work.

PUNJAB. Agricultural Associations continued to function in almost every district, and as many of the members were prominent practical farmers they formed a valuable link between the department and the farmers.

BIHAR AND ORISSA. The Provincial Agricultural Association which had not functioned for 20 years was revived. Among its useful activities is the publication of quarterly Hindi journal, which is popular.

CENTRAL PROVINCES. There were 24 Taluq Agricultural Associations functioning in the Western Circle, besides 8 Agricultural Societies and 8 Branch Associations. Few of these are reported to have shown any enterprise, but two associations did excellent work in the marketing of Verum cotton. The Seed-Unions in the Eastern Circle, which numbered 213 and 223 in the two years, were responsible for a large amount of the seed-supply.

ASSAM. The honorary correspondents who assisted the department in propaganda work numbered 104 and 115 in the two years.

NORTH-WEST FRONTIER PROVINCE. Six Agricultural Associations have been started in this province.

SIND. A Provincial Board of Agriculture has been constituted consisting of officials and non-officials. The Board met in 1933 and reviewed the progress made in agricultural and co-operative propaganda work. The number of Taluqa Development Associations which functioned was eleven and many of these maintained *kamgars* for demonstration work. The question of establishing Rural Development Societies based upon more homogeneous agricultural units is under consideration.

MYSORE. The Mysore Agricultural and Experimental Union continued to take interest in agricultural improvements and also conducted a journal in English and Kannada.

HYDERABAD. The Hyderabad Farming Association is reported to be doing useful work and continued to issue a quarterly journal which has proved useful and popular.

5. Seed Multiplication and Distribution.

The supply of improved seed has always been an important part of the work of the agricultural departments in India. At Pusa, the birth-place of many of the improved varieties now extensively cultivated in India, a supply of pure seed of various crops is maintained for the provincial departments of agriculture. This seed is utilized for renewing the sowing seed on various Government farms in the provinces. New types produced at Pusa are also sent to provincial departments for trial. The success of Pusa 114 wheat in Sind is an example of a recent improvement due to the introduction of a new type.

The larger number of suitable types of improved crops now available for the varying conditions obtaining in each province and the comparatively larger areas that are coming under improved types have necessitated a considerable expansion of

departmental activities in the matter of seed-supply. A noteworthy feature is the substantial assistance which several provinces have recently received from the Indian Central Cotton Committee in the wider distribution of seed of improved cottons; no less than 16 cotton seed-extension schemes have been sanctioned by that Committee and of these 11 were in operation in 1932-33.

MADRAS. In Madras the department continued to pay special attention to paddy and cotton. The total paddy seed actually issued from the departmental farms amounted to 280 tons in 1932-33 as compared with 200 tons in 1931-32 and 160 tons in 1930-31. In addition, large areas of seed-farms on ryots' lands under departmental supervision were arranged and sufficient seed for about 1½ lakhs of acres in 1931-32 and 3 lakhs of acres in 1932-33 was produced and distributed. The area under private seed-farms for cotton was 7,881 acres in 1931-32 and 10,954 acres in 1932-33 and the quantity of seed distributed amounted to 8·46 lakhs of pounds in 1931-32 and 10·79 lakhs of pounds in 1932-33. A scheme financed by the Indian Central Cotton Committee for the extension of Co. 2 cotton in the Coimbatore district came into operation in 1932-33 and another, also financed by that Committee, for the extension of the H-1 strain in the Bellary district, will be started next year.

BOMBAY. In Bombay special attention was given to cotton for which there were in all five seed-multiplication schemes operated with the financial assistance of the Indian Central Cotton Committee. These schemes were run on the model which was outlined in the previous review. The first stage in each scheme is a small plot under the immediate charge of the plant-breeder who arranges that all plants are self-fertilized and there is no crossing with outside plants. In the second stage the self-fertilized seed is grown on a larger scale on a Government farm where it is also kept free from contamination by other varieties. The next two or three stages are laid out in the lands of registered seed-growers, who grow the seed

according to instructions and permit the departmental officers to rogue the fields, and the produce is collected and ginned separately and the pure seed obtained is stocked for the next season, the operations being managed with the help of co-operative societies wherever possible. In the Hubli-Jayawant Cotton Seed Scheme, which is now in its third year of operation, a total area of 68,500 acres was put down under pedigree Jayawant cotton in all the different stages, in the last cotton season, and 1,510,800 lbs. of seed stocked for the next sowing. Under the Gadag Cotton Seed Scheme, which is also in its third year, the total area sown with pedigree Gadag No. 1 cotton in the different stages in the last season was 54,100 acres and the seed stocked for next sowing amounted to 1,200,000 lbs. The Khandesh Banilla Cotton Seed Scheme has now completed two years and the total area under pure Banilla cotton last season was 4,677 acres and the seed stocked for the next season's sowing amounted to 629,980 lbs. Similarly, in Surat where 1027 A. L. F. is the improved strain under distribution, the area under pure seed was 13,627 acres and the seed stocked for distribution was 2,582,673 lbs. In the Kumpta-Dharwar tract a new seed-multiplication scheme was started last year at Athani, where the seed to be multiplied is Jayawant and a reserve area of 1,000 acres has been organised in the coming season. With these elaborate schemes in progress a steady advance has been made in the area under improved cottons which is now 658,565 acres as compared with 570,551 acres in 1931-32 and 410,296 acres in 1930-31. A system of multiplication through registered seed-growers has been adopted for rice and *nagli*.

SIND. A commencement has been made with similar seed-extension schemes for cotton and wheat; the schemes are now in the second stage of their development. The total seed of all kinds distributed by the department amounted to 2,411 cwts. in 1931-32 and 1,250 cwts. in 1932-33, the reduction in the second year being due to a part of the seed being utilized for the departmental seed-multiplication schemes.

BENGAL. An efficient organization has been built up for the distribution of improved varieties of paddy through union boards and co-operative societies. In 1931-32, 245 seed-centres, covering 8,200 *bighas*, were organized and next year 228 seed-centres covering an area of 8,877 *bighas*. The total quantity of seed supplied from these seed centres and from Government farms amounted to 13,818 mds. in 1931-32 and 15,547 mds. in 1932-33. In order to encourage the cultivation of sugarcane as a substitute crop for jute, a record supply of 52 lakhs of cane setts was arranged in 1931-32. Next year the supply amounted to 13 lakhs. The area under improved canes is estimated at 125,000 acres, as against 100,000 acres in 1930-31.

UNITED PROVINCES. In this province a definite beginning has recently been made in organizing private seed-farmers; and steps are also being taken to utilize agricultural and co-operative societies for seed-distribution and to encourage the creation of self-help seed associations. By utilizing such private agencies marked progress has been made of late in the quantity of seed supplied. The total seed of all kinds distributed from seed-stores and Government and private farms amounted to 2,035,455 mds. in 1932-33 as compared with 948,752 mds. in 1931-32 and 1,059,840 mds. in 1930-31. The bulk of the increase has occurred under sugarcane for which the seed-supply amounted to 1,783,192 mds. in 1932-33 as against 780,444 mds. in 1931-32 and 879,202 mds. in 1930-31, the greatest increase being recorded in the Western Circle as a result of the interest taken by sugar factories in improving the cane in their neighbourhood. In regard to wheat, which comes next in importance, the total seed-supply amounted to 156,259 mds. in 1932-33 as against 139,932 mds. in 1931-32 and 142,702 mds. in 1930-31. Marked progress has recently been made under paddy for which the supply amounted to 64,311 mds. in 1932-33 as against 6,192 mds. in 1930-31.

PUNJAB. In this province the department distributes the improved seed produced on Government farms through two agencies, *viz.*, non-official commission shops and official seed-

agencies. The total amount of seed distributed to cultivators by these agencies was 48,529 mds. in 1931-32 and 52,951 mds. in 1932-33. The amounts of cotton and wheat seed distributed were 21,048 and 21,764 mds. in 1931-32 and 18,781 and 25,375 mds. in 1932-33. The seed-supply for sugarcane amounted to 7,325 and 3,510 mds. in the two years under review, and Government continued to assist in encouraging the introduction of improved canes by providing funds to meet the cost of transport. It is reported that the Punjab Sugar Corporation at Sonepat contributed largely to the spread of improved varieties within the area commanded by their factory by importing improved seed from other areas and supplying it on credit to registered growers.

BURMA. Special attention was given to paddy as usual. In addition to 20 major seed-farms covering nearly 2,500 acres, 124 and 133 " grazing ground seed-farms " covering 7,842 and 7,964 acres, respectively, were controlled during the two years under review, as compared with 107 such farms covering 6,571 acres in 1930-31. The total paddy seed distributed from all sources amounted to 10,564,256 lbs. in 1931-32 and 11,560,409 lbs. in 1932-33 as compared with 8,873,590 lbs. in 1930-31. The seed-supply in regard to the other crops amounted to 797,684 lbs. and 741,447 lbs. in the two years under review.

BIHAR AND ORISSA. In the absence of proper seed-farms the multiplication of pure seed is undertaken in the large and small departmental farms. The area available being, however, very limited, an attempt was made in 1929 to introduce a system of registered seed-growers, but on account of the fall in prices no advance could be made with it. The quantity of seed-grain and cane setts supplied from the departmental farms amounted to 5,700 mds. and 18,540 mds. in 1931-32, and 6,800 mds. and 23,600 mds. in 1932-33, as against 5,715 mds. and 11,360 mds. in 1930-31 respectively. The bulk of the increase under cane has occurred in North Bihar where the supply amounted to 8,014 mds. and 121,335 mds. in the two years.

CENTRAL PROVINCES. The total number of private seed-farms controlled by the department increased from 16,205 in 1930-31 to 18,682 in 1931-32, but fell to 17,274 next year. The total seed distributed, however, showed a continued decline from 495,179 mds. in 1930-31 to 477,037 mds. in 1931-32 and again to 445,413 mds. in 1932-33. The seed-supply for wheat increased from 152,938 mds. in 1930-31 to 193,036 mds. in 1931-32 but showed a slight decline next year when it amounted to 192,985 mds. In the case of cotton, however, there has been a continuous fall from 142,537 mds. in 1930-31 to 70,079 mds. in 1931-32 and 38,885 mds. in 1932-33 owing to successive unfavourable cotton seasons, which made it difficult to secure sufficient supply of seed of the requisite standard of purity. The seed-supply for groundnut increased from 59,636 mds. in 1930-31 to 66,280 mds. in 1931-32, and decreased by only 111 mds. next year. Steady progress has been maintained in the issue of paddy seed and seed-cane, the supply of which in the three years amounted to 129,782, 135,831 and 138,840 mds. of paddy and 1,081,312, 1,179,963 and 1,987,519 setts respectively.

The marketing arrangements for Verum cotton were conducted on the same lines as in previous years with the financial assistance of the Indian Central Cotton Committee. The department was able to distribute in the two years 5,134,416 lbs. and 1,052,650 lbs. of pure Verum cotton seed, sufficient to sow about 2½ lakhs and 71,000 acres respectively and to handle through the departmental pool 2,255 bales in the first year at a premium of Rs. 59-12-0 over Broach and Rs. 63-9-0 over Oomras, and 3,971 bales in the second year at a premium of Rs. 36-13-0 over Broach and Rs. 55-11-0 over Oomras.

ASSAM. The three departmental seed-depôts issued for sale and demonstration purposes 160,911 lbs. of paddy, 165,602 lbs. of potatoes and 124,874 cane setts in 1932-33 and 1,490 mds. of paddy, 1,005 mds. of potatoes and 109,073 cane setts in 1931-32.

HYDERABAD. The department distributed 962 cwts. of improved seed in 1931-32 and 1,269 cwts. in 1932-33; about 92 and 95 per cent. of these represented cotton seed.

MYSORE. The quantity of *ragi* seed supplied from seed-farms amounted to 2,000 *pallas* in 1931-32 and 685 *pallas* in 1932-33, the decrease in the second year being due to the heavy rains damaging some of the seed at harvesting time. In connection with the extension of sugarcane cultivation in the Irwin Canal Area, nearly 7 lakhs of sugarcane setts were distributed in 1931-32 and next year the whole cane crop of 200 acres was cut and supplied for seed purposes in that tract.

6. Implements.

In Appendix V will be found a statement of the agricultural implements sold through departmental agency. The most notable feature is the general falling-off in the number of implements issued, which was due to the general shortage of capital among the farming classes during the period. But even then these figures are no real measure of the extent to which improved implements were handled by cultivators. Both manufacture and sale by private agencies is reported to be increasing in several provinces, and the agricultural associations and co-operative societies in certain places have been doing good work in the hiring of implements.

The total sales of all agricultural implements through departmental agency in British India amounted to 42,905 in 1931-32 and 67,354 in 1932-33, as compared with 49,998 in 1930-31. The number of ploughs sold has declined from 25,513 in 1930-31 to 17,853 in 1931-32 and 17,193 in 1932-33, but a satisfactory feature is the increase in the number of spare parts sold, indicating that the cultivators were more inclined to repair their old implements than incur fresh expenditure. Sales of cane-mills increased from 5,792 in 1930-31 to 6,700 in 1931-32 and then fell to 6,368 in 1932-33. The sales of fodder-cutters decreased from 12,800 in 1930-31 to 7,911 in 1931-32 and then rose to 20,281 in 1932-33—the bulk of the sales of this implement being in the Punjab. Demonstrations of improved implements continued to be given in all the provinces, and ploughing

matches were conducted wherever possible though paucity of funds checked progress in this direction.

MADRAS. The department gave an increased number of demonstrations with different kinds of ploughs and with the H. M. Guntaka (5,000 in 1931-32 and 6,800 in 1932-33). No correct figures are available of the number of ploughs purchased but approximately 880 were purchased by the public in 1931-32 and 1,394 in 1932-33. Among the other implements that were extensively demonstrated may be mentioned the roll-easy *mhote* wheel, Archimedian screws, Junior hoe and seed-drill.

BOMBAY. The sales of ploughs and cane-mills have increased, most of the sales being in the Deccan Canal Area. The department has followed the policy of entrusting this work to private bodies and individuals, who can run the work on business lines. Several of the Taluka Development Associations maintain implement depôts and hire out implements to a number of non-credit co-operative machinery and implement societies.

BENGAL. In spite of the depression, the improved ploughs designed by the Agricultural Engineer are reported to have sold well. There has been an increase in the number of cane-mills at work.

UNITED PROVINCES. The implements and parts issued from the departmental depôts decreased from 14,455 in 1930-31 to 13,435 in 1931-32, owing to a general reduction in the purchasing power of the farmer. In 1932-33, the number increased to 14,127; the increases occurring mainly in the issues of Meston ploughs and chaff-cutters. The number of Persian-wheels sold fell from 973 in 1931-32 to 545 in 1932-33, but private enterprise in the manufacture of this implement is reported to be active.

PUNJAB. In addition to the departmental sales the private manufacture of implements was going on on a fairly large scale; in fact, as a result of the work of the department, a new industry in the manufacture of implements is flourishing in Batala, Jullundur and various places. In Batala alone there were 28 foundries working, which made well over 13,000 and 8,800 implements in the two years under review, estimated to

be worth Rs. $2\frac{3}{4}$ lakhs and Rs. 2 lakhs respectively. A special feature was a temporary increase in the demand for centrifugal machines for sugar-making by the open-pan system. Assistance was given in the building of improved furnaces for *gur* and *rab* manufacture. In Jullundur Circle alone 1,127 such furnaces were constructed. Fewer ploughing competitions were held on account of paucity of funds.

BURMA. In Burma sales of the popular Theikpan plough and plough-share declined from 661 and 6,637 in 1930-31 to 202 and 2,314 in 1931-32 and then increased to 417 and 3,846 in 1932-33. But the plough-shares were being made by private agencies and many more were distributed from centres of local manufacture.

BIHAR AND ORISSA. In North Bihar, Mr. Cliff's implements, the Bihar plough, the Bihar ridging plough and the Bihar cultivator are becoming increasingly popular. *Rahat* water-lifts are now well-known in all tracts where well-irrigation is practised. A number of local *mistries* in South Bihar have taken up its manufacture and are reported to have sold a large number.

CENTRAL PROVINCES. The plough sales decreased from 2,700 in 1930-31 to 1,835 in 1932-33, but a satisfactory feature was the increase in the number of spare parts sold from 14,324 in 1930-31 to 18,596 in 1932-33—a sure indication that the ploughs were being used. The decrease in the plough sales was due mainly to the shortage of capital amongst the farming classes and the tendency to hire from Agricultural Associations and Village Societies rather than to purchase them outright. Another feature is the increase in the number of cane-mills issued from 112 to 240. There was an increasing demand for the Persian water-wheel or *rahat*, especially in the Northern and Southern Circles. Several associations are doing excellent work in hiring out cane-mills and other implements.

7. Fertilizers.

The fall in the prices of agricultural produce curtailed the use of costly manures generally, except for cash crops such as

sugarcane, potatoes, fruits, etc. In regard to chemical fertilizers, a considerable amount of propaganda continued to be carried on by private firms, and this combined with a fall in the prices of such fertilizers as ammonium sulphate has led to an extension in their use being reported from several parts. At the same time agricultural departments have increased their efforts to popularise the practice of preparing composts from organic waste, better methods of preservation of farm-yard manure and the use of green manures wherever possible. Imports of fertilizers including ammonium sulphate totalled 34,097 tons in 1931-32 and 52,676 tons in 1932-33 compared to 59,497 tons in 1930-31. Indian production of ammonium sulphate amounted to 12,133 tons in 1931 and 9,474 tons in 1932 and approximate consumption of ammonium sulphate to 25,469 tons in 1931 and 46,783 tons in 1932 as compared to 31,190 tons in 1930.

MADRAS. There has been a decline in the use of oil-cakes and artificial fertilizers, though in regard to the latter some progress has been made in the first and second Circles. The application of nitrogenous manures to plantain and sugarcane and of bone-meal to paddy in conjunction with green manures, is reported to be extending in the Godavari delta. Vigorous propaganda was continued to encourage the general adoption of improved methods of manure-preservation and composting and an increasing number of manure and compost pits were started at the instance of the department. The increased demand for green manures has led to a considerable rise in the departmental seed issues, which amounted to 174 tons in 1931-32 and 380 tons in 1932-33 as compared with 115 tons in 1930-31.

BOMBAY. The use of artificials mainly for sugarcane is reported to be increasing in the Deccan districts, where the Imperial Chemical Industries, Limited, have opened a number of depôts in the Canal Areas. The agricultural department also carried on vigorous propaganda in the Canal Areas to popularise green-manuring with *sann*, the cultivation of which was encouraged by the offer of concessional water rates and free

distribution of seed. About 132,000 lbs. of seed in 1931-32 were distributed and 34,476 lbs. in 1932-33, most of it free.

BENGAL. The production of artificial farmyard manure on Government farms and sericultural nurseries has now come up to 90,000 mds. annually, as against 25,000 mds. in the previous period.

UNITED PROVINCES. The quantity of oil-cakes and chemical fertilizers issued from departmental depôts decreased from 43,870 mds. in 1930-31 to 34,670 mds. in 1931-32, doubtless owing to the reduced purchasing power of the ryots. But in 1932-33 the amount increased to 46,876 mds.; there was an increase of 9,000 mds. in oil-cakes and 5,200 mds. in ammonium sulphate, the latter tending to replace to a certain extent the more expensive sodium nitrate. Several trade agencies were actively engaged in fertilizer propaganda. Special attention was paid on all experimental and demonstration farms to the utilization of all waste matter for the manufacture of improved composts or artificial farmyard manure.

BURMA. Though the depression has checked the extension in the use of chemical fertilizers, private firms have been carrying on active propaganda and their total sales amounted to approximately 110 tons in 1931-32 and 200 tons in 1932-33. The department recommended the use of these fertilizers on paddy nursery plots and on sugarcane. The use of bone-meal for paddy is reported to be popular in the delta districts.

BIHAR AND ORISSA. A simple and effective method of composting has been worked out at the Gaya Farm. On account of the agricultural department's work, supplemented by the efforts of the manufacturing firms, artificial fertilizers are being used extensively in the province and the co-operative movement is also taking an active part in their spread. Gypsum, a natural and inexpensive manure which is useful on certain South Bihar soils, is becoming popular in Shahabad and Patna districts and nearly 1,600 mds. and 5,000 mds., respectively, were sold in the two years under review.

CHAPTER IX.

AGRICULTURAL EDUCATION.

There was a marked falling-off in the number of students seeking admission to the agricultural colleges during the last two years, which was probably due to the temporary cessation or reduction of recruitment to the subordinate agricultural services in all provinces and to the restricted prospects of employment in government and other services during this period of financial stringency.

1. Agricultural Colleges.

MADRAS. The number of applications for admission to the Coimbatore Agricultural College dropped from 365 in 1930-31 to 321 in 1931-32 and then again to 180 in 1932-33. The Selection Committee chose 45 and 48 students for admission in each of these two years. In 1931-32, 48 students took the B.Sc. Part I examination and of these 31 passed. Of the 56 that appeared for the B.Sc. Part II examination, 31 qualified for the degree. In the next year 31 of the 48 candidates for Part I and 54 of 59 candidates for Part II were declared successful. As a measure of economy, tuition and lodging, which were hitherto free, were charged for, the tuition fee being Rs. 120 per annum. Five or six scholarships were again awarded in each year to students of minority and backward communities. A new feature was the encouragement of research by members of the staff for post-graduate degrees of the Madras University; two members of the staff were awarded the M.Sc. degree on presentation of theses. Three graduates of the college have joined the Chemical Section as research students for the M.Sc. degree.

BOMBAY. The affairs of the Poona Agricultural College came in for a good deal of discussion, both public and private, in the early part of 1933, when the question of its abolition or retention was engaging the attention of government. The Re-

organization Committee of the Bombay Government recommended the abolition of the college on grounds that it had failed to attract youths who desired an agricultural education for its own sake and that it had been filled almost entirely by aspirants to government service. Fortunately wiser counsels prevailed and the Committee's recommendation was not accepted by the Government of Bombay, which held that the college was serving a useful purpose in the training of men not only for the Agricultural Department but also for taking up agriculture and allied professions. In the Local Government's view the abolition of the college would have left a definite gap in the educational system of the presidency and might check its agricultural progress. It was decided to continue the college with the proviso that the cost of running it should be reduced and the fees enhanced. As a result the college has suffered considerable curtailment of its staff and resources, and the tuition fees which were Rs. 60 per annum in 1930-31 have been raised to Rs. 120 for students of the Bombay Presidency and to double that amount for outsiders. There has been a falling-off in the number of applicants for admission from 139 in 1930-31 to 100 in 1931-32 and 83 in 1932-33, and of the 50 and 78 students chosen for admission into the college only 44 and 55 actually joined the course. Of the 82 students who appeared for the final degree examination in 1931-32, 58 were declared successful, and in the next year 77 out of 86 qualified for the degree. Post-graduate students at the college numbered 5 and 7 in the two years under review, and two students were awarded the M.Ag. and one the M.Sc. degree during the period. An attempt was made a few years ago to ascertain the careers of past students of the college and the results are interesting. Of 398 graduates, 310 were in service, private or government, connected with agriculture, 68 were engaged in private farming, 19 were in service, private or government, not connected with agriculture and one in private business.

BENGAL. Owing to the continued financial depression, the Dacca Agricultural Institute has not materialised and its

establishment still appears remote. Some years ago the Bengal Government decided to proceed with the scheme in parts by starting the Engineering and Dairying Sections which, with the facilities already available, would have enabled a reasonably good course in practical agriculture to be given. In view of the keen demand for higher agricultural education which is reported to exist in the province, it is hoped that this decision of government may take practical shape.

UNITED PROVINCES. As the outcome of an enquiry held into the working of the Cawnpore Agricultural College, the teaching work of the college has been re-organised with a view to greater efficiency. Though accompanied by a distinct reduction in the staff, the re-organisation has led to an improvement in the organisation of teaching, the important changes being the centralization of teaching work under a Principal who is also Professor of Agriculture—aided by four Assistant Professors for the different subjects, the separation of teaching and major research, the introduction of the batch system for practical and out-door work and an arrangement for leasing out to *ex*-students holdings of about 20-25 acres each on the College Farm with a view to enable them to acquire practical experience in commercial farming. In 1931-32, out of 120 applications received, 50 were admitted into the college, the total number on the roll being 160. Whilst in 1931-32, of 125 applications received, 61 were admitted and the total strength of the college was 168. Thirty-eight students sat for the final B.Ag. examination in 1930-31 and of these 37 passed; the corresponding numbers for 1931-32 were 40 and 28. The fall in the percentage of passes in the second year is reported to be due to a general tightening up of the standard. A distinct improvement is reported in the quality of the newly admitted students, and a noteworthy feature since 1930 has been the rise in the percentage of candidates whose object is private farming and fall in the numbers desiring for government service.

PUNJAB. The applications for admission to the B.Sc. (Agr.) course of the Punjab Agricultural College declined from 102

in 1931 to 75 in 1932 and 76 in 1933. The fall is attributed to the inability of farmers at the present time to finance a four-years' course of education in a residential college for their sons and to the comparatively few opportunities of securing government service. The number of students selected for admission was 56 and 59 respectively, a satisfactory feature being an improvement in the educational qualifications of the candidates admitted. In the final examination for the B.Sc. (Agr.) degree, the record number of 75 students appeared in 1931-32; of these 34 passed whilst 24 failed in one subject only. In the next year the results were better; of the 61 students that appeared 47 were successful and 10 failed in one subject only. A new feature was the introduction of Agricultural Entomology and Zoology as a major subject for the degree. Two students obtained the M.Sc. degree in this period. The two years' Leaving School Certificate Course was taken advantage of by eight students in each of the two years; six were successful in the final examination in 1931-32 and eight in 1932-33.

The Khalsa College at Amritsar now gives a complete course of instruction leading up to the B.Sc. (Agr.) degree of the Punjab University and the Islamia College, Peshawar, has recently been affiliated to the Punjab University for the F.Sc. in Agriculture.

BURMA. With the cessation of recruitment to the subordinate services in Burma, admission to the Mandalay Agricultural College was suspended in 1930-31, with the result that in that year there were only second and third year classes in attendance; these contained seventeen and nine students respectively. In the final diploma examination held that year, eight of the nine students passed successfully, whilst of the eighteen who sat for the final examination in the next year, fifteen qualified for the diploma, three being placed in the first class. With the departure of the third year students the teaching activities of the college came to an end temporarily and the institution will devote itself entirely to research until recruitment to the agricultural department is resumed.

CENTRAL PROVINCES. There was a fall in the number of applications for admission to the Nagpur Agricultural College from 132 in 1930-31 to 84 in 1931-32 and 75 in 1932-33; this is attributed to the restricted prospects of employment in government service. The admissions in the two years numbered 54 and 32 and the total number of students being 106 and 112 respectively. Owing to the closure of the college in August 1930, no final examination was held in 1932. At the final examination held in 1933, 28 students appeared and 24 passed. No students were placed in the first division but 18 passed in the second division. A quinquennial inspection of the college was carried out on behalf of the Nagpur University and the inspectors pronounced the general tone of discipline in the college to be excellent.

MYSORE. The Hebbal Agricultural School in Mysore worked successfully during the period and is reported to be increasing in popularity. Of the 134 candidates who applied for admission in the first year only 31 could be accepted owing to limited accommodation. The total strength of the school was 84 in each year. Twenty-nine students sat for the final examination in the first year and 16 were declared eligible for the diploma, two obtaining distinction. In the next year, 29 appeared for the examination and of these 21 qualified for the diploma.

2. Post-graduate Training in Agriculture.

The Imperial Institute of Agricultural Research, Pusa, with sub-stations at Bangalore, Wellington, Karnal and Coimbatore, continued to offer facilities for post-graduate training in the various branches of agricultural science. In 1931, five post-graduate students completed their two-year course at Pusa, three in Botany and one in Mycology and Entomology. One Assistant from the United Provinces Department of Agriculture and another from the Jaipur State completed the special one-year course in farm organisation, farm management and general farm engineering. There were 40 applicants for the session beginning on the 2nd November, 1931; 12 were selected for

interview, of whom two were admitted in Botany but one left the course after three months' training on obtaining an appointment. Two students joined the Agricultural Section for a special one-year course but one left for domestic reasons, without completing the course. The fifteen-months course in animal husbandry, animal nutrition and dairying at Bangalore was completed by two students in April 1932. Due to the uncertainty prevailing at the time regarding the future of the dairy farms at Bangalore and Wellington, no fresh admission was made to this course in January, 1932.

The position as regards the qualifications for admission to these courses was reviewed in 1932, and, on the advice of the Imperial Council of Agricultural Research, it has been decided that (1) distinguished graduates who have obtained the highest degree in science (short of a doctor's degree) awarded by their university, or an honours degree in science of a high standard or its equivalent, graduates of agricultural colleges who have passed in the first class or have otherwise attained a high position in the college gradation list, and selected officers of agricultural departments provided that they are fully qualified to take advantage of the course and are recommended by the government of the province in which they may be serving, will in future be eligible for admission to these courses; and (2) that in each province there will be a selection committee on which due representation is given to universities, and that the recommendations of such selection committees will go before a committee at Pusa which will have the final voice in the selection of students. Selection committees have accordingly been constituted in some provinces and of the 34 candidates applying for admission to the session beginning in November, 1932, fifteen were the nominees of such committees. Sixteen applicants were selected for admission, seven in Botany (of whom two left subsequently on obtaining appointments), one in Entomology, two in Chemistry, three in Sugarcane Breeding and three in General Agriculture. Five students completed their training at Pusa in October, 1932, three in Botany, one in Chemistry, and one

in Farm Organization, Farm Management and General Farm Engineering. The fifteen-months course in Animal Husbandry, Animal Nutrition and Dairying, was completed in April, 1933, by one student originally admitted in January, 1931, and one student joined for the new session beginning in January, 1933. Twenty out of a class of 24 students qualified for the Indian Dairy Diploma in the examination held at Bangalore in December, 1931, one with honours. A new class with 20 students was opened in October, 1931.

3. Agricultural Schools.

School education in agriculture continued to be in demand in several provinces.

MADRAS. The Agricultural Middle School at Taliparamba, which had fallen in popularity in recent years, was abolished at the end of April 1932 as a measure of retrenchment. In its last year the school had 11 students in the first and second-year classes and of these 3 left in the middle of the year.

The Agricultural Middle School at Usilampatti, which is maintained by the Madura District Board, is reported to be growing in popularity, the number of students on the rolls increasing from 23 in 1931-32 to 38 in 1932-33. The majority of the students belonged to the Kallar community for whom the school was intended. The three Farm Labourers' Schools at Anakapalle, Coimbatore and Palur worked satisfactorily.

BOMBAY. Of the Vernacular Schools at Devihosur, Dhulia and Loni, the one at Loni came under retrenchment in 1931-32; the other two are reported to have done excellent work. The Loni School, which was the original school of its type, had, in the course of 22 years, turned out 357 boys and 51 ' bias ' school teachers; most of whom have been found efficient workers either in government and private institutions or in practical farming. The Devihosur School which has completed its 19th year, had 35 and 28 students on the rolls in the two years, and granted certificates to 16 and 14 students respectively. Notwithstanding the reduction in the number and value of the

scholarships, 92 and 81 applications were received for admission, but owing to lack of accommodation only 14 and 12 could be admitted. It is gratifying to learn that out of the 251 students so far turned out by this Institute 137 have settled down to private farming and are doing excellent work. The school at Dhulia, which is partly financed by contributions from local bodies, had 33 and 31 students on the roll and granted certificates to 17 and 15 during the two years.

BENGAL. The Dacca Secondary Agricultural School, which is practically the only institution in Bengal where elementary agriculture on sound practical lines is taught, admitted 17 and 16 students in the two years, the total number on the roll being 38 and 28 respectively. Ten students passed the final examination in 1931-32 and 8 in 1932-33. The school is meant only for students belonging to the agricultural classes and is reported to be making satisfactory progress although no prospect of appointment is offered to the successful students.

UNITED PROVINCES. The Agricultural Schools at Bulandshahar and Gorakhpur continued to give a two-year certificate course in practical agriculture, and in addition the former gave courses for fieldmen and farm mechanics and the latter a course for fieldmen. The Bulandshahar School had a total strength of 77 in 1931-32, 62 for the certificate course and 6 and 9 respectively for the fieldman and farm mechanic courses. Of the 32 students who appeared for the final certificate examination, 31 were successful; all the fieldmen and farm mechanics passed their final test. In 1932-33 there were 59 students in the certificate classes; of these 29 appeared for the final examination and 28 were successful. All seven fieldmen and seven out of nine farm mechanics passed the final test. The School at Gorakhpur which was started in July, 1931, had 30 students in the first year class out of whom 29 were promoted to the second year. Next year, the school admitted 32 students including six candidates from Hyderabad. All the 29 students that sat for the final examination were successful. A large percentage of the candidates of this school owned sufficient

landed property to take up farming as their profession. All the six candidates who took the fieldmen's course were successful at the final test.

A village uplift school with a farm attached to it was started in June, 1931, as part of the Moss Agricultural and Village Improvement Institute, by the Ghazipur Agricultural Association. The object of this Institute is to impart instruction in practical farming so as to fit the outgoing students to earn a decent living as farmers or as managers of private farms. The school turned out 14 trained students during the period June, 1931 to March, 1933.

BURMA. The Pyinmana Agricultural School, which provides an agricultural training in addition to the ordinary middle school curriculum, is maintained by the American Baptist Mission. The school had a total strength of 80 and 81 students in all the four year classes during the two years. Owing to financial stringency the government grant to this institution has been reduced and proposals are therefore under consideration for a reduction in the courses, scholarships and staff and a restriction of the number of students.

CENTRAL PROVINCES. The Powarkhera Agricultural Anglo-Vernacular Middle School had a successful career during the period. The total strength of the school during the two years was 81 and 84 respectively, and the students were either sons of *malguzars* or cultivators. The successful students at the high school entrance examination numbered 17 in 1931-32 and 23 in 1932-33. An important feature was the ample scope for individual agricultural practice afforded to all the students, all of whom evinced great interest in maintaining their plots in good condition. In order to cheapen the course, steps have been taken to reduce the mess charges and to keep the cost of training at as low a figure as possible. Another school of the Powarkhera type has recently been started at Betul Bazar under the auspices of the local District Council and the status of the school is being raised by successive stages to that of Powarkhera. The Peace Memorial School at Buldana, which has been

working from 1929, continued to function during the period. The agricultural department was responsible only for the training in agriculture and allied subjects, while the general management of the school and of the hostel rested with a committee.

MYSORE. In Mysore the Vernacular Schools at Chikkanahalli, Hassan and Ramakrishnapur have had a successful two years. In 1930-31, 42 sat for the final examination from the three institutions together and 41 of them passed, 15 with distinction. The performance of the school at Ramakrishnapur was particularly good; all the 15 students that appeared passed, 12 with distinction. A beginning has been made with the interesting experiment of leasing out blocks of land to passed students of these schools: two selected pupils have been given seven acres of land with a house to live in, besides facilities for cultivation. The progress of the experiment is being watched with interest.

TRAVANCORE. Of the Agricultural Schools at Alwaye, Kottarakara and Koni, the first-mentioned was closed as a measure of retrenchment in 1931-32, after having turned out 15 successful students in that year. The school at Kottarakara admitted 29 students of whom nine discontinued their course. The Koni school had 52 students on the roll of whom 48 came out successful in the final examination. A fresh batch of 29 students has been selected and they are reported to be making good progress.

4. Rural ' Bias ' Schools.

The system of introducing agricultural classes in vernacular middle schools has produced good results in all the provinces where it had been tried and will doubtless be extended further in rural areas as funds permit.

BOMBAY. The agricultural ' bias ' schools run by the education department numbered 76 in 1931-32 and 90 in 1932-33, and are reported to be increasing in popularity. The Agricultural Department's Inspector of Agricultural Schools paid regular visits to these schools, assisted and advised teachers in conducting examinations, framing sets of experiments, etc.

The improvement of the syllabus, particularly under agricultural arithmetic, is engaging his attention.

BENGAL. The scheme for the introduction of agricultural classes into secondary schools in Bengal has made further progress. Four batches of teachers have been trained at the Dacca Secondary School and have joined their schools. There are now 57 such schools in the province; excluding 14 which were only recently started, the total strength of the 42 schools was 1,909 and the total area of the school gardens and farms 141·5 acres. The attitude of both students and guardians is said to be improving. Pending a final decision on the success or otherwise of the scheme, no more teachers were sent for training at the Dacca Agricultural School.

UNITED PROVINCES. There were 12 vernacular middle schools with agricultural classes in the Sarda Circle, of which six have farms of their own. A number of middle schools in the Western Circle and also in the Rohilkhand and Kumaun Circles have opened agricultural classes. The teachers are mostly trained men from the agricultural schools of the department, and the departmental staff continued to be in touch with these schools and helped by giving lectures on agricultural subjects and conducting practical demonstrations.

PUNJAB. The one-year course for the training of teachers of the ' bias ' schools was taken at Lyallpur by 23 and 12 teachers in the two years, the fall in the number being due to the fewer number of school gardens opened during the period on account of financial stringency. There were 71 school farms and 91 school gardens in the province—all run by teachers trained by the department.

BIHAR AND ORISSA. Three middle English and Vernacular schools in the province have experimental gardens attached to them and the agricultural department rendered assistance in making the agricultural classes interesting and instructive.

MADRAS. The vocational school at Muthanandal maintained by the Ramnad District Board introduced agriculture in its

curriculum and an agricultural diplomate was added to the staff.

5. Short Courses.

Short courses on special subjects continued to be given with profit to those taking them.

At PUSA a special short course in flue-curing tobacco was given in January and February of the years under review. The course was attended in each year by about ten officers from departments of agriculture which were interested in tobacco-curing.

BOMBAY. In the Deccan Canals Area in Bombay 55 classes extending over short periods varying from 1-3 days were given in 1931-32 on various agricultural improvements; the number of such classes given next year totalled twenty-five. Special short courses were also given on irrigated crops, land-development, horticulture, tractor-driving, sugarcane cultivation and vegetable and tobacco-growing. A one-year practical course in horticulture provided at the Ganeshkhind Botanical Gardens is reported to be gaining in popularity. Six weeks' courses on Farm Costing and Cost Accounting were conducted in Malsira in the Sholapur district and some 30 students took advantage of these in each of the two years.

In the UNITED PROVINCES the short courses were stopped as a measure of economy.

PUNJAB. In the Punjab the two vernacular courses in practical agriculture, each of six months' duration, were attended at Lyallpur by 27 and 19 students in 1931-32 and 13 and 5 students in 1932-33. These courses qualify for service as *mukaddams* in the department and as no recruitment was made, there was a fall in the number of students applying for this course. A month's course in rural economics was attended by 11 and 9 officers of other departments in the two years. With a view to increase the usefulness of this course, it has been decided to conduct it in two sections in future, each in alternate years, one for officers of the Superior Service and the other

for those of the Subordinate Service. A six-weeks' course for blacksmiths was availed of by 12 and 19 pupils in the two years. The short courses in fruit-culture and fruit-preservation continued to be given and gained in popularity. Only a small proportion of the applicants could be admitted owing to the limited accommodation available.

BURMA. In Burma the Farm Schools at Hmawbi and Mahlaing Agricultural Stations were continued. At Hmawbi a nine months' training class in practical agriculture was attended by nine and ten students in the two years. Most of the out-going students went back to work their own land or that of their relatives. A similar course of practical training at Mahlaing, extending over ten months, was attended by a dozen students each year. Some of the successful students were appointed as temporary demonstrators in the department but most of them took to farming. In addition to these farm schools, shorter demonstration courses were given on several of the experimental farms when funds permitted but necessity for economy has resulted in a serious curtailment of this work. The practice of inviting school pupils to make excursions to these farms was continued and extended.

6. Adult Education.

In several provinces the agricultural departments have given assistance to the adult education movement.

In the UNITED PROVINCES the work of training supervisors and teachers for the adult schools started at Partabgarh in collaboration with the Registrar of Co-operative Societies was continued, and so far 124 supervisors and 17 trained teachers have been turned out, and 69 candidates are under training. There were 30 and 58 Adult Schools in Partabgarh District in the two years, each school being in charge of a trained teacher, who being a local resident was best fitted to influence the uneducated minds. The work of these teachers was supervised by the Co-operative Supervisors and village guides. These schools usually continue for two or three years, after which

they are converted into useful village reading clubs, which will be provided with literature on agriculture, co-operation and allied subjects. In the Sarda Circle the adult-education co-operative societies did useful work and the agricultural staff attended their meetings and delivered lectures.

CHAPTER X.

THE CO-OPERATIVE MOVEMENT AS AFFECTING AGRICULTURE.

The period 1931-33 was a particularly difficult one for co-operative societies in all provinces and the movement in general received a severe set-back due to the general economic depression. Up to 1930-31 there had been a continuous growth in the number of societies and in membership. From 1931 all co-operative departments had perforce to abandon expansion, or at least move with the greatest caution, and concentrate effort on securing greater efficiency. Many societies had to be liquidated, and unsatisfactory members eliminated from others, loans had to be restricted just when most needed and generally speaking official control had to be tightened. The obvious and fundamental difficulty was the reduced repaying capacity of members of village societies which was due to the step-fall in prices. Over-dues consequently increased and caused anxiety. It was quickly realised, however, that hasty measures to reduce over-dues, and any undue harshness in dealing with individual cases, might only make matters worse. It was clear that, if the co-operative movement is to be of any real value to the Indian agriculturist it must stand by him in adversity and not only provide him with relatively cheap loans, perhaps too readily, in times of relative prosperity. Apart from the general measures of consolidation and rectification special attention was devoted to the question of such reduced rates of interests and longer instalments for repayment as were compatible with sound finance. It was also realised by co-operative leaders that to prevent the expropriation of rural land-holders long term loans on comparatively low rates of interest are needed, that ordinary credit societies cannot safely or adequately undertake this task and that land mortgage banks or similar institutions need to be developed. Naturally also

the relations of the co-operative movement to debt conciliation measures, and all other methods of relieving rural indebtedness came in for close consideration. During 1933 the Government of India decided to call an all-India Conference of Registrars of Co-operative Societies and other leading co-operative workers, to consider these and other questions of importance. The proposal was welcomed by all local governments and 2 Ministers of Agriculture, 20 Registrars and officials closely connected with the administration of co-operative credit and 19 leading unofficial co-operative workers attended the Conference which met in January 1934 with the Hon'ble Sir Fazl-i-Husain as president. The ten Governors' Provinces, two centrally administered areas and seven Indian States were represented. Though strictly outside the period covered by this review, the resolutions of the Conference are reproduced below—a discussion of the resulting action falls within the sphere of the next report :—

Resolutions passed at the Eleventh Conference of Registrars of Co-operative Societies in India.

1. The Conference considers that a provision restricting by law the transfer of property by indebted members without the consent of societies is neither advisable nor practicable. (Item 2 of the Agenda.)

2. (*a*) The Conference is of opinion that it is not desirable to exclude members of co-operative societies from the provisions of Insolvency Act; but is of opinion that the Insolvency Acts should be so amended that an order of discharge passed by an Insolvency Court shall not release an insolvent member of a society with unlimited liability from the liability for any debt due to the society.

(*b*) The Conference is in favour of the introduction of a simplified Rural Insolvency Bill. (Item 3 of the Agenda.)

3. (*a*) In view of the experience in several provinces that liquidation through non-official liquidators has not been successful, the conference considers that liquidators should generally be government officials, but where suitable non-officials are available they may be employed.

(*b*) The Conference considers that the cost of liquidation should fall on the society under liquidation, or on a group of societies in such proportion as the Registrar may decide.

(*c*) No remedies of universal application can be recommended for expediting liquidation proceedings, but the Conference supports the principle of a proposal that the Registrar be empowered by law to take

possession of the books, records and assets of the society immediately on the issue of an order of cancellation, during the period allowed for an appeal against such order. (Item 30 of the Agenda.)

4. (i) The Conference understands that the legal position of arbitration proceedings under the Co-operative Societies Act has been questioned in certain quarters. It approves of the provisions in regard to the settlement of disputes embodied in Section 51 of the Madras Act and considers that some such provisions are necessary in order to protect the decisions of the Registrar and of an Arbitrator from interference by the Civil Courts, and to ensure that the actual proceedings are not delayed by orders of injunction in such courts.

(ii) The Conference feels that as the Registrar has exclusive control over the process of passing decrees, he should have similar control over the process of execution. At the same time it is not desirable that the work of the ordinary staff of the co-operative department should include the application of coercive process. The remedy appears to lie in the institution of a special branch of the co-operative department whose officers would be concerned only with the execution of co-operative societies' decrees. The expenses of such officers would be largely met by the levy of process fees. (Item 31 of the Agenda.)

5. The Conference considers that all-India legislation is necessary for the registration of co-operative societies, the operations of which extend over all-India or more than one province. The Conference supports the principle and general provisions of the Draft Bill on the subject framed by the Government of India. The Conference further recommends that the question be examined of the possibility of societies registered in Indian States joining an all-India association registered under the proposed legislation. (Item 1 of the Agenda.)

6. The Conference is of opinion that as a result of the economic depression, the overdues in co-operative societies have increased alarmingly owing to reduced repaying capacity of borrowers and there is a possibility of decrease of deposits and curtailment of fresh finance. If it should ever become necessary, government should give a long-term loan to assist such banks as require it. The Conference is of opinion that in view of the present depression, the duties of the officers of the co-operative department have increased greatly, and strengthening of the co-operative staff is necessary, as there is greater need than ever for the activities of the co-operative department.

The Conference is of opinion that:—

(*a*) in view of the present depression, the rate of interest charged by primary societies should be temporarily reduced as far as possible, consistent with the safety of the society, even at the cost of not leaving a margin for contribution to the reserve fund;

(*b*) the instalments payable to the societies may be spread over a longer period as far as the resources would permit; and

(*c*) fresh finance should be given to the members consistent with the safety of the funds. (Item 7 of the Agenda.)

7. The Conference is of opinion that in order to prevent the expropriation of the rural land-holder, wherever adequate security exists, Government should provide the long-term capital for this purpose, if necessary. (Item 8 of the Agenda.)

8. The Conference is of opinion that in view of favourable circumstances for debt conciliation, co-operative organisations should render all assistance for this purpose and that where necessary the long-term capital for this purpose should be obtained on such guarantee by government as would facilitate raising of the requisite amount of money at cheap rates. (Item 9 of the Agenda.)

9. The Conference is of opinion that it is difficult to lay down any general rules for determining the methods by which the repaying capacity of members is to be estimated and the remedy if such capacity is found to be *nil*, and that the problem must be solved with regard to the actual conditions in different provinces. (Item 10 of the Agenda.)

10. The Conference is of opinion that:—

(*a*) steady expansion of non-credit societies is necessary, provided the requisite staff is available; and

(*b*) caution expansion of the credit societies is desirable, as any movement which fails to advance is likely to deteriorate. (Item 11 of the Agenda.)

11. The Conference is of opinion that rural reconstruction work is essentially the application of co-operative principles to village life. A central organisation is, however, necessary to co-ordinate the work of all the departments, without affecting their independence, in order to supply the necessary driving force. The agency in the village for this purpose should be the village *panchayat;* but where the *panchayat* is ineffective or does not exist, the establishment of rural reconstruction societies should be encouraged; and for this purpose the staff of the co-operative department should be strengthened. (Item 12 of the Agenda.)

12. The Conference is of opinion that expansion of co-operative sale societies is essentially desirable as profits from agriculture are dwindling. Such societies cannot be formed unless suitable local talent is available to secure the loyalty of the members. Where it is available, government should provide trained staff for guiding the societies in the initial stages. Adequate facilities for financing members of these societies for all purposes of cultivation should be provided by credit societies operating in the same area, otherwise the members are likely to sell part of their produce to the local dealers. (Item 13 of the Agenda.)

13. The Conference is of opinion that, in view of the present circumstances, the time has not yet come for slackening the official control. (Item 17 of the Agenda.)

14. (1) The Conference considers that the seasonal needs of the members for finance should be more closely studied and met as far as possible. It would be inadvisable to stop the flow of deposits in the central banks either by reducing rates of interest or by any other means, where such funds can be profitably employed, and each province according to its conditions should find ways of investing surplus capital such as by advances by central banks to members of societies and co-operative institutions against the security of grain, cotton or other produce placed in their godowns, where expert control and conditions permit.

(2) There should be no bar as to making advances against gold deposit, by members of a society or central bank, where adequate arrangement for testing, valuation, custody, etc., can be made. (Item 19 of the Agenda.)

15. The Conference observes that the question of cash credit and overdraft facilities is covered by the provision in the Reserve Bank Bill as passed by the Legislative Assembly, Section 17 (*b*).

Pending the establishment of the Reserve Bank the Conference is of opinion that the Imperial Bank should be asked to give similar facilities to those provided for in the Bill. (Item 20 of the Agenda.)

16. The Conference notes that the question of granting loans against produce to members and of raising capital by short-term bills is covered by the provision in the Reserve Bank Bill as passed by the Legislative Assembly, Section 17, subsection (iv) (*d*). Loans against produce can, however, only be given where adequate warehousing arrangements exist or can be made. (Item 21 of the Agenda.)

17. The Conference is of opinion that primary societies and central banks should not undertake long-term business and redemption of prior debts, but co-operative land mortgage banks should be established for undertaking such business wherever there is a right of free and unrestricted transfer of lands. Where these conditions do not prevail, or elsewhere as a temporary measure, arrangements should be made to float debentures through the provincial co-operative bank (or through central banks where there is no provincial bank) with government guarantee for the purpose of placing on a sufficiently long-term basis existing advances which have proved unrealizable within the period fixed for their repayment provided that the security is adequate and repaying capacity sufficient. The owned capital of central banks may, if necessary, be utilized as cover for such long-term loans to a limited extent, provided that no portion of the banks' reserves should be so utilized. The question of granting fresh long-term credit through the existing agencies where land mortgage banks cannot be started will have

to be considered in the light of the experience so gained. (Item 22 of the Agenda.)

18. The Conference is of opinion that the present system of co-operative land mortgage banking in the provinces of Madras, Bombay, the Punjab and Assam requires modification in the following directions:—

(1) the maximum period of loans should be extended to 40 years;
(2) the rate of interest should be reduced as low as possible;
(3) there should be a government guarantee of principal as well as of interest;
(4) efforts should be made to extend the operations of these banks so as to cover the entire existing debt in all cases in which the conditions governing land mortgage banking are satisfied;
(5) land mortgage banks and the other co-operative credit institutions should as far as possible work in co-ordination in supplying the long and short-term needs respectively of the rural co-operators.

19. The Conference recommends on the facts placed before it that government should encourage the establishment of co-operative land mortgage banks in provinces where they do not already exist and where conditions are suitable. (Item 23 of the Agenda.)

20. The Conference considers that the problems arising from the purchase of lands, whether by societies or banks, must be dealt with locally according to local conditions, but is strongly of opinion that purchase of lands should be resorted to only as a last resource and to the least extent possible. (Item 26 of the Agenda.)

21. The Conference is of opinion that the reserve fund may properly be used for writing-off bad debts as a last resort, but cannot be used for meeting demands of creditors until liquidation.

The Conference is emphatically of opinion that the reserve fund cannot be used as fluid resources in the central banks. (Item 27 of the Agenda.)

22. The standards of fluid resources vary from province to province and the Conference is not therefore able to make any general recommendation for their reduction. (Item 28 of the Agenda.)

23. The Conference considers that there should be no restriction on the transfer of funds free of cost by Remittance Transfer Receipts for *bonâ fide* co-operative purposes, as recommended by the Indian Central Banking Enquiry Committee (recommendations 40 and 41). (Item 29 of the Agenda.)

A heartening feature of a somewhat dismal period was the continued success of a considerable number of non-credit co-operative societies. Some details are given in the provincial

summaries which follow—and also in Chapter IX. It is sufficient to say here that there has been a growing realisation of the importance and value of such societies and of the need for well-considered expansion. Indeed there has been a better appreciation of the position of the co-operative movement in relation to rural reconstruction and village uplift work in general.

The position of the co-operative movement in the various provinces may now be summarised briefly :—

Madras. From 12,967 in 1930-31 the number of agricultural societies fell to 12,064 in 1932-33. During the same period the membership figures fell from about 715,000 to some 629,000. These societies distributed Rs. 92·37 lakhs in loans to their members in 1932-33 as compared to Rs. 97·43 lakhs in the previous year and Rs. 163·50 lakhs in 1930-31. The ratio between the short and long-term loans was 3 : 2 and 53 : 47 respectively during the two years under review.

The number of agricultural credit societies dwindled from 12,439 in 1930-31 to 11,623 in 1932-33. The total membership of these societies fell from 676,000 to about 593,000.

At the commencement of 1931-32 there were 108 PURCHASE AND SALE SOCIETIES but only 79 remained at the end of the year 1932-33. In that year the purchases made by these societies amounted to Rs. 2,61,000 and the sales to Rs. 6,61,000. The profits of some of these societies which made any amounted to Rs. 16,891 and the losses of the others to Rs. 14,717. The 13 Milk Supply Societies supplied milk to the Madras Milk Supply Union which earned a net profit of Rs. 2,337 by the sale of milk and milk products. The 11 *Kudi maramat* and Irrigation Societies undertook the cleaning of silt and the irrigation of channels. About 5,000 acres in 1931-32 and some 4,000 acres of land in 1932-33 were irrigated with the water supplied by the Irrigation Societies, the total number of members benefited being 293 and 394 respectively in the two years. The twelve LAND RECLAMATION SOCIETIES continued to work and had reclaimed 1,724 acres upto the beginning of the

year 1932-33. Eight hundred and fifteen acres of land still remained in their area of operation to be reclaimed.

Of the 10 AGRICULTURAL DEMONSTRATION SOCIETIES only 5 worked during 1932-33. These societies demonstrated the value of improved methods of paddy and sugarcane cultivation on 59·33 acres, the results being compared with the traditional method of cultivation adopted in 10·3 acres of control plots. At the same time these societies sold improved varieties of seed, manure, etc., to members to the value of about Rs. 23,000 and to non-members to the value of over one lakh of rupees.

Bombay. The policy of consolidation and rectification which resulted in the liquidation of weak societies and the weeding out of undesirable members who continued during the period under review. As a result there was a decline in the total number of societies which fell from 4,889 in 1930-31 to 4,818 in 1932-33; the total membership declined from 339,000 to 317,000 and the working capital from Rs. 449 lakhs to Rs. 424 lakhs. The reserve funds however, increased from Rs. 66 lakhs to Rs. 73 lakhs during the same period.

AGRICULTURAL CREDIT SOCIETIES. In pursuance of the above-mentioned policy the registration of 42 societies was cancelled and only 12 new societies were registered in 1932-33 as against 144 and 97 respectively in the year 1931-32. This reduced the total number of credit societies from 4,650 to 4,573 in the two years ending with 1932-33. Membership also decreased by about 20,000 and the working capital by Rs. 23 lakhs in the same period. The large drop in the membership figures is due to the weeding out of undesirable from existing members as well as to the breaking up of unsatisfactory societies. Similarly the drop in working capital is due in part to the withdrawal of deposits, as the prevailing depression necessitated the utilisation of their savings by many agriculturists.

The co-operative department has pursued its policy of rectification by insisting on better supervision, better staff, more careful scrutiny of loan applications and by a lowering the individual limit for loans in consonance with the decline in

commodity prices. At the same time, membership is being restricted to those who are both economically and morally desirable.

The percentage of over-dues increased from 39 per cent. in 1930-31 to 50 per cent. in 1932-33. Various factors have contributed to these unsatisfactory figures. Though the fall in prices and land values, was doubtless the main cause, other factors such as over-financing in the past and some instances of wilful default have contributed.

The appointment of a special recovery officer to recover the dues and to check default has proved to be beneficial. Owing to the low price of *gur*, the condition of three Canal Societies continues to be serious. The price reached its lowest ebb in 1932-33.

AGRICULTURAL NON-CREDIT SOCIETIES. Societies for the sale of agricultural produce, especially cotton, are the most important of the agricultural non-credit societies. Though most of these did successful business, during the two years under review, the unsettled condition of the market and the lack of efficient staff checked the development of this movement. Apart from cotton sale societies, there were 36 sale societies, in 1932-33 dealing with other products. Of the three, Mango Sale Societies in Ratnagiri district, two did good work. Four paddy societies, however, were badly affected due to the decrease in price but efforts are being made to readjust according to the situation. In Sind the model Grain Society at Shikarpore worked well.

The number of PURCHASE AND SALE UNIONS remained unchanged. Mention may be made of the Nira Canal Purchase and Sale Union which made a net profit of Rs. 4,400 in 1931-32 and the Nasik District Sales Union which realised a profit of Rs. 1,000 in 1932-33.

Of the 11 MANURE SOCIETIES four were cancelled during the period under review. In 1931-32, these societies supplied about 90 tons of fertilisers and made a profit of about Rs. 1,000.

In 1932-33 their business was more than doubled. The 26 MACHINERY AND IMPLEMENTS SOCIETIES supplied goods worth Rs. 1,10,000 and realised Rs. 47,000 from commission and the hire of implements. The three DAM-CONSTRUCTION SOCIETIES continued their useful activities. The Mutta Dam Construction Society builds a temporary dam annually at a cost of Rs. 400 and enables the members to grow two crops a year on about 450 acres of irrigated land. The Salukatta Dam Construction Society built a permanent tank at a cost of Rs. 6,586 and irrigated 150 acres out of a total of 223 acres commanded.

The 14 FENCING SOCIETIES with a membership of 1,162 and a working capital of Rs. 64 thousand control a total area of 11,292 acres. They have built 57,910 yards of wire-fence and stone-walls at a total cost of Rs. 62,257 and have thus enabled many farmers to grow valuable crops like sugarcane, which were previously almost impossible on account of the damage caused by wild animals.

The seventeen CATTLE BREEDING SOCIETIES maintained 15 breeding bulls and 579 cows in 1932-33 as against 17 breeding bulls and 649 cows in the previous year.

The Siddenur Cattle Society in the Bombay Division has been most successful. Besides improving their own stock, this society encourages others to improve their stock by advertising the benefits of improved breeds of livestock.

Punjab. While the total number of all agricultural societies increased from 17,541 to 17,726, and membership from 569,000 to 574,000 during the two years under review, the number of Agricultural Credit Societies, decreased from 16,297 to 16,268 with a decrease in membership of about 15,000 and a fall in the working capital by some Rs. 8 lakhs. No further expansion is being attempted but the department is now confining its activities to keeping weak societies in life and heart so that they may once again become useful after the depression has passed away. At present, desirable members show a tendency to leave their societies after paying their dues. This may be due either to the fear of enforcement of the

unlimited liability clause or to the default of their fellow members causing a reduction in the credit of their society with the financing banks, thus making it difficult for desirable members to get loans from the society when needed. In some instances the withdrawal of members is also attributable to the severity with which the action has been taken against defaulters and it behoves societies to consider whether by such means they are not likely to defeat their own object.

The amount advanced by the societies to their members during 1931-32 and 1932-33 was about Rs. 159 lakhs as against Rs. 356 lakhs advanced in the previous two years. The bulk of the loan was absorbed in the repayment of debts, purchase of cattle and payment of revenue—in that order of their importance. The percentage of recoveries of principal to the amount outstanding amounted to 16 and 13 respectively for 1932-33 and 1931-32, a figure which is not very encouraging for it has been reached by steady deterioration from the 35 per cent. five years ago.

AGRICULTURAL NON-CREDIT SOCIETIES. The CONSOLIDATION OF HOLDINGS continues to be one of the main activities of the co-operative department. During the last two years 220 new societies were registered and 20 cancelled. This brings the grand total to 1,011. In the same period these societies succeeded in consolidating 122,410 acres scattered over 193,604 blocks; after consolidation the number of blocks was only 32,844. Further development in this direction was restricted by the fact that the staff at the disposal of consolidation societies has been steadily cut down during the last two years. The total cost of consolidation to the government was Rs. 1,23,000 in 1931-32, Rs. 1,13,000 in 1932-33 which works out to be Rs. 2-0-7 and Rs. 1-13-1 respectively per acre consolidated. This expenditure is by no means unproductive. For example, figures received from a village in Gurdaspur district show that the cultivated area rose from 615 to 1,372 acres and the land revenue from Rs. 2,059 to Rs. 2,938 as the result of consolidation. Again the number of new wells sunk following consoli-

dation is no less than 1,741 for the province, thus indicating the increased cultivation of the more valuable crops in consolidated villages.

During the period 1931-33 the number of CO-OPERATIVE COMMISSION SHOPS in the province decreased from 25 to 23, individual membership from 3,595 to 3,338 and the value of the produce sold from Rs. 30 lakhs to 19 lakhs. This movement is reported to have experienced a definite set-back due to the discovery of a number of embezzlement cases involving about Rs. 50,000. Special efforts are now being made both to tighten the control over the working of the shops and on the other hand to stimulate the loyalty of members and to induce them to sell all their produce through their own shops. Only six shops were able to pay a dividend and two distributed a rebate in addition in 1932-33. Two of the five Unions and five of the 19 SOCIETIES FOR PURCHASE AND SALE, are in an unsatisfactory and moribund condition. The others which are mostly in the Criminal Tribes Settlements, are doing well and show an increase both in membership and working capital. The CROP FAILURE RELIEF SOCIETIES, which form the bulk of the Agricultural Thrift Societies, increased from 62 to 71; every one of these is having a hard time and eight LAND REVENUE REDEMPTION SOCIETIES are in an even worse condition but efforts are being made to keep them going as their value in time of crop failure is obvious.

MORTGAGE BANKS. All the 12 Banks have been struggling to collect their dues, and there has been no fresh business worth mentioning. It is not only that banks are unwilling to advance loans but that the members of the banks rightly consider that under the present condition borrowing at 9 per cent. to redeem mortgaged land is not a business proposition. Loan repayments in 1932-33 totalled Rs. 1·34 lakhs as compared with Rs. 1·60 lakhs in 1931-32, and Rs. 1·77 lakhs in 1930-31. Over dues have gone up considerably during the two years under review. The figures for 1930-31 was Rs. 1·85 lakhs which jumped up to Rs. 3·90 lakhs in 1931-32 and to Rs. 4·30

lakhs in 1932-33. The total loss on the last year's working was Rs. 33,000.

Assam. The floods of 1929 and the general economic depression which started soon after are reported to have greatly affected the co-operative movement and which made the work of the department difficult. The number of agricultural societies decreased from 1,304 to 1,292, and membership from 55,315 to 52,204 during the two years under review. There was however an increase of about Rs. 541 lakhs in the working capital during the same period. Consolidation rather than expansion continued to absorb the time and attention of the co-operative department. At the same time societies with unwieldy areas were split up in order to improve supervision and control. In 1931-32 primary societies issued loans to the extent of Rs. 2,54,000 and recovered Rs. 2,18,000 outstanding the figures for 1932-33 being Rs. 85,000 and Rs. 1,37,000 respectively. Attempts have been made to supplement the income of the members of rural societies in suitable localities by encouraging subsidiary occupations, such as weaving and sericulture. None of the five Land Mortgage Banks can be said to have worked very satisfactorily and it is difficult to predict the future of these banks at present.

Central Provinces and Berar. Due to the continuance of the economic depression, no appreciable improvement could be expected in the general condition of the movement during the last two years. The total number of Rural Credit Societies with unlimited liability decreased from 3,915 in 1931-32 to 3,689 in 1932-33. During the same period the membership of societies other than those under liquidation fell from 58,000 to less than 53,000 and the working capital from Rs. 168 lakhs to 159 lakhs. The total loans advanced by societies to members during the two years under review, was Rs. 26,12,000 and Rs. 26,51,000 respectively, as compared to Rs. 37,35,000 in 1930-31. The principal purposes for which loans were taken were the purchase of bullocks and plough-cattle, expenses of cultivation, repayment of debts, improvement of land and

payment of revenues. The unsatisfactory position in Berar arising from the concentration of big loans in the hands of a few members continued and though the number of such loans was slightly reduced, the total amount is increasing due to default in payment and the consequent accumulation of interest.

The Non-Credit Agricultural Societies, of which there were 57, consisted of two land-holders associations, 34 agricultural associations, 11 seed unions, and 10 commission shops. The two land-holders' associations besides working for the general improvement of agriculture, advance loans to their members. They made a profit of Rs. 2,706 in 1931-32 as against Rs. 2,222 in 1932-33. Owing to the dearth of honorary workers the agricultural associations, with few exceptions, did not do good business. The activities of the *Adat* shops were restricted owing to the slump in trade.

Delhi. Though there was an insignificant fall from 217 in 1930-31 to 216 in 1932-33 in the number of Agricultural Credit Societies, the membership figures of the same showed a considerable decline from 5,083 to 4,636 during the same period. There is scope for expansion but it was not considered advisable to form new societies during this period of depression. The movement has touched 54 per cent. of the villages and 20 per cent. of the total population of the province. It is regretted that on the whole well-to-do people are keeping away from the movement and there is a tendency on the part of members to withdraw as soon as a loan is paid off, the main reason being to avoid the consequences of unlimited liability later on.

The percentage of recoveries of the principal worked out at 4·3 per cent. in 1932-33 as against 4·2 per cent. in the previous year and 3·6 per cent. in 1930-31. It is however disconcerting to note that the arrears of interest are increasing.

The work of CONSOLIDATION OF HOLDINGS, which is only five years' old, has been completed in 8 villages comprising 533 cultivators and an area of 4,594 acres divided into 11,930 blocks. This has now been reduced to 1,769 blocks and the

average area per block has increased from 0·38 to 2·5 acres. The government expenditure increased from Rs. 1-4-6 in 1931-32 to Rs. 1-8-6 per acre consolidated in 1932-33 but this compares favourably with the figure for 1930-31 which was Rs. 2-3 per acre.

Bengal. In view of the present economic situation, the department continued to direct its attention towards the consolidation of the movement by assisting societies to make the best possible collection of their outstandings and by improving bad societies. The securing of additional income to members from subsidiary occupation continue to receive attention including the cultivation of such subsidiary crops as sugarcane and potatoes as well as cottage industries. The organisation of new societies of all classes was almost entirely stopped.

AGRICULTURAL CREDIT SOCIETIES. The number of societies under this head, including Grain Banks fell from 20,172 to 20,009 and the number of members decreased from 477,000 to about 465,000. The working capital however increased by Rs. 31,000. The continuous slump in the prices of agricultural commodities rendered collection of dues more difficult and the repayments by members dropped from 14·1 per cent. of the total amount due in 1930-31 to 10·8 per cent. in 1931-32 and 8·4 per cent. during 1932-33.

In view of the present state of agricultural finance the question of providing easy credit facilities in the shape of long-term loans bearing a reasonably low rate of interest and repayable by small instalments and the question of establishing CO-OPERATIVE LAND MORTGAGE BANKS engaged the attention of the local government.

The number of AGRICULTURAL PURCHASE AND SALE SOCIETIES, mostly of Paddy Sale Societies, declined from 95 in 1930-31 to 85 in 1932-33, the membership fell from 12,935 to 11,468 and the working capital from Rs. 7,13,000 to Rs. 6,61,000. In spite of the fact that the price of paddy was still very low, most of the societies did good business during this period. The Nagaon Ganja Cultivators Co-operative Society sold 1,945

maunds of *ganja* and 307 maunds of *bhang* and made a profit of about a lakh of rupees in 1931-32. A considerable proportion of this profit was devoted to works of public utility especially to schools and dispensaries.

Of 932 IRRIGATION AND DRAINAGE SOCIETIES as many as 917 were in the Burdwan Division. The Khelar Irrigation Society in Midnapore district and three irrigation societies in Hooghly district were in a very bad condition.

The number of CO-OPERATIVE AGRICULTURAL ASSOCIATIONS fell from 38 to 36 in 1931-32 but again rose to 38 in 1932-33. The Nagaon Agricultural Association which is the largest of its kind maintained a farm of its own and started a sugar factory. With the exception of this society and one other, the Lal Garh Krishi Samity which only started work in 1932-33, these societies either worked unsatisfactorily or did practically no work. There was an increase of 5 in the number of MILK SOCIETIES which now stands at 269. Of these 114 were situated in the Presidency Division and worked well. The societies affiliated to the Calcutta Co-operative Milk Societies Union earned a profit of Rs. 8,442 in 1932-33 as compared to Rs. 18,536 in 1930-31, the decrease being due to the fall in the price of milk. Of the six CATTLE BREEDING SOCIETIES only two did some useful work.

North-West Frontier Province. Unlike other provinces the number of Agricultural Credit Societies in the North-West Frontier Province increased from 239 in 1930-31 to 353 in 1932-33. The membership similarly increased from 5,923 to 8,280 and the working capital from about Rs. 5½ lakhs to nearly Rs. 7 lakhs during the same period. The training of the members of the new societies proceeded with energy and emphasis was laid on thrift, better living, better business, better education and better farming. This resulted in opening of more schools for boys and girls on the one hand and the increased use of better implements, and good seed on the other.

An effort has been made to restrict the amount of loans to real needs and, as far as possible, to loans for productive

purposes such as the purchase of cattle, repayment of debts, payment of land revenue and purchase of seeds and agricultural requisites. The total amount advanced in 1930-31 was 3·41 lakhs as compared to 1·78 lakhs in 1932-33.

Six new societies for the CONSOLIDATION OF HOLDINGS have been registered and these consolidated 16,374 *kanals* of land, the number of blocks being reduced from 3,586 to 743. The cost of consolidation was Rs. 3 per acre in the first year but dropped down to Rs. 2-7-5 in 1932-33.

United Provinces. A slight increase occurred in the number of Co-operative Credit Societies which rose by 73 during the two years under review thus bringing the total head to 5,083 for the year 1932-33. The membership figure, however, continued to decline and fell from 1,13,000 to 1,06,000 during the same period. The working capital decreased from Rs. 104·6 lakhs in 1930-31 to Rs. 100·7 lakhs in 1932-33, but the share capital and reserve funds rose from Rs. 48,33,000 to Rs. 52,20,000, with the result that the owned capital is now 55·05 per cent. of the working capital. The number of societies able to distribute a dividend fell from 1,150 to 1,077.

SUPPLY AND SALE SOCIETIES. The 23 Cane Supply Societies continue to be prominent. These supplied over two lakhs of maunds of cane in 1932-33 and distributed over Rs. 2,000 as bonus to members out of their net profits. The Ghee Societies which increased in number from 11 in 1930-31 to 23 in 1932-33 enjoy good reputation and commanded a better price for their produce. All of them worked at a profit during the period under review. The two Cotton Sale Societies worked at a loss which was attributed to late ginning, dryage and a sudden fall of prices. Of the three Agricultural Supply Societies only one worked satisfactorily.

Bihar and Orissa. The total number of agricultural societies decreased from 8,817 to 8,599, during the two years under review and the membership figures fell from 2,35,000 to 2,31,000. The majority of these were primary credit societies which numbered 8,518 with 208,782 members and a working

capital of Rs. 219·32 lakhs at the end of the year 1933. The cost of management of these societies was over 1¼ lakhs of rupees annually and efforts are being made to reduce this.

The 70 GRAIN GOLAS had a membership of 21,753 and a working capital of Rs. 3·51 lakhs in the year 1932-33. Thirty-four of these were in Angul and made a profit of Rs. 19,897 in 1932-33 as against Rs. 20,550 in 1931-32. With the exception of 15 Golas, 10 of which are in Cuttack circle, these societies worked satisfactorily. The only other agricultural societies still working are :—a society for the PURCHASE AND SALE OF AGRICULTURAL IMPLEMENTS at Nawada; a MANURE-SALE SOCIETY in Banka, two IRRIGATION SOCIETIES in Fatwa and a DAIRY SOCIETY in Bhagalpur. The dairy society suffered from a series of embezzlements committed by its staff and hence worked at a loss. The others were in a moribund condition.

Mysore. Due to the winding up of hopeless societies and caution in the registration of fresh societies, the total number of Agricultural Co-operative Societies fell from 1,777 in 1930-31 to 1,723 in 1932-33 of which 1,723 were purely credit societies. The working of this class of societies was greatly affected by the prevailing economic depression and membership figures fell from 68,073 in 1932 to 67,724 in 1933. Loans to the extent of Rs. 10·5 lakhs were issued in 1933 as compared to Rs. 11 lakhs and Rs. 16 lakhs during 1932 and 1931 respectively. The net profits also declined largely due to the non-realisation of interest from defaulting members.

Of the three COTTON SALE SOCIETIES, the Credit Society in Maradihalli, which undertakes the sale of cotton as well, did satisfactory work. This society distributed 918 maunds of improved cotton grown by them. The society was able to dispose of this cotton at Rs. 108 per candy of 500 lbs. as compared to Rs. 103 per candy realised for the local lint. Of the two Cardamom Sale Societies only one worked at a profit.

The number of SUPPLY SOCIETIES decreased from 48 in 1931-32 to 45 in 1932-33. These societies effected sales of agricultural implements, seeds and manures, to the value of

Rs. 9,809. The 54 Grain Banks did not function properly and there being no possibility of working these banks successfully it was considered desirable to wind them up as early as possible.

Baroda. The Baroda State showed an increase in the number of Agricultural Co-operative Societies which rose from 861 in 1930-31 to 939 in 1932-33. Among these the most prominent were Primary Credit Societies which numbered 767 in 1932-33. Instead of starting new societies for new purposes efforts are being made to persuade members of old established village societies to undertake further functions and to increase their membership. Of 31 COTTON SALE SOCIETIES 18 worked successfully last year and sold 13,064 *bhars* of cotton lint for about Rs. 13½ lakhs and thus made a profit of Rs. 53,040. Of the 7 CO-OPERATIVE POWER-PUMPING SOCIETIES, three supplied water for 3,828 hours at a charge of 0-12-0 to 1-8 per hour. Five out of 8 CO-OPERATIVE PURE SEED AND MANURE SOCIETIES distributed about 25,000 lbs. of improved seed and about 1,960 lbs. of fertiliser to their members.

CHAPTER XI.

PUBLICATIONS OF THE AGRICULTURAL DEPARTMENTS.

Imperial. The Imperial Council of Agricultural Research continued the publication of its three Journals, ' Agriculture and Livestock in India ', ' The Indian Journal of Agricultural Science ' and ' The Indian Journal of Veterinary Science and Animal Husbandry ', the first two being issued bimonthly and the last quarterly. The total number of original articles published in ' Agriculture and Livestock in India ' was seventy, of which forty-nine related to soils and crops and twenty-one to animal husbandry matters. Of the ninety-four original articles published in ' The Indian Journal of Agricultural Science ', fifty-one may be classed as botanical, twenty-one as chemical, six as entomological, ten as mycological and two as bacteriological. In ' The Indian Journal of Veterinary Science and Animal Husbandry ', forty-nine original contributions were published, of which thirty-eight related to diseases of livestock, six to animal-breeding and nutrition and five to dairying. The sizes of edition for these journals during the period under report were 1250, 950 and 900, respectively.

In addition to the three Journals, the Council also brings out special monographs from time to time. During the period under report the following three monographs were issued :—

No. 1. The Fungi of India, by Dr. E. J. Butler, C.M.G., C.I.E., D.Sc., F.R.S., and Dr. G. R. Bisby, Ph.D.

No. 2. Life-histories of Indian Microlepidoptera (Second Series); Alucitidae (Pterophoriidae), by T. Bainbrigge Fletcher, R.N., F.L.S., F.E.S., F.Z.S.

No. 3. The Open-Pan System of White Sugar Manufacture, by R. C. Srivastava, B.Sc.

Five other monographs were in the press at the end of the period.

Provincial and State publications. The MADRAS DEPARTMENT of Agriculture published, in English and in the vernaculars, thirty-seven ' Leaflets ', six ' Notes ', four ' Broad Hints ', three ' Pamphlets ' and one ' Handbill '; and all these were distributed free of cost. In addition, seven numbers were issued in the ' Bulletins ' series, with vernacular versions for three. The annual " Villagers' Calendar " continued to be printed in English and in the four principal vernaculars of the Presidency, the size of edition running to more than 55,000 each year. ' A Handbook of South Indian Weeds ' by Rao Bahadur C. Tadulinga Mudaliyar was also published. The Madras Agricultural Students' Union continued to publish its monthly magazine, " The Madras Agricultural Journal ", with the active help and co-operation of the departmental staff.

The BOMBAY DEPARTMENT issued thirty-three popular leaflets with vernacular versions. The Bulletins issued during the period numbered seven. The Poona Agricultural College continued to issue its quarterly magazine, which is serving a useful purpose in keeping the past students of the college in touch with the institution and with the work of the agricultural department.

In BENGAL, the Department issued thirteen popular leaflets in English and in Bengali, embodying the practical recommendations of the Department.

The UNITED PROVINCES Department issued six vernacular leaflets embodying the practical recommendations of the Department, and three Bulletins in English, two on electro-farming and the third on papaya cultivation. A special ' Fruit Bulletins ' series was started and three numbers were issued in that series, two more being in the press at the end of the period. The two departmental vernacular agricultural journals, *Mufid-ul-Mazarain* (Urdu), and *Kisan Upkark* (Hindi), have been brought into headquarters under a new editor, and the quality of their contents considerably improved. Their circulation is reported to be on the increase.

The number of agricultural leaflets issued by the PUNJAB Department of Agriculture was thirteen. The Department continued to publish the ' Seasonal Notes ' half yearly. Mention may also be made of the eight numbers in the " Rural Section series ' of the Punjab Board of Economic Enquiry, which were published during the period.

In BURMA, the Department issued eight cultivators' leaflets in English and in Burmese. In addition, eight numbers were issued in the series of ' agricultural surveys ', of which two dealt with the soils of the Pegu District and the Mandalay Canal area, respectively, and the rest with the important crops of the province, *viz.*, rice, tobacco, sesamum, groundnut and potato. As a measure of economy the issue of the Agricultural Calendar was suspended during the period.

In BIHAR AND ORISSA, the Department issued ten leaflets and nineteen Bulletins. Four Bulletins embodied the departments' recommendations on the cultivation of sugarcane and the manufacture of sugar by the open-pan method. There were also Bulletins on ' fruit cultivation in Orissa ', ' cultivation of berseem in Chota Nagpur ', ' the manufacture of *gur* from the juice of the palmyra palm ' and the preparation of artificial farmyard manure.

In the CENTRAL PROVINCES, the Department issued fourteen popular leaflets with vernacular versions and six Bulletins, of which two had their vernacular versions also. The Nagpur Agricultural College Magazine continued to be published quarterly.

In ASSAM three popular leaflets were issued, two on the cultivation of tobacco and vegetables respectively, and the third on betel-vine disease.

Six leaflets in vernacular were issued by the Department in HYDERABAD STATE. The Hyderabad Farming Association continued to publish its quarterly magazine ' The Hyderabad Farmer ' which continued to be useful and popular.

The MYSORE DEPARTMENT issued seven circulars and five Bulletins. Four of the latter related to the work of the Mysore

Coffee Experimental Station and included an important Bulletin on the ' Seasonal Periodicity of Coffee Leaf-Disease '.

In TRAVANCORE, the department issued twenty-three leaflets mostly in the local vernacular, and a large number of copies were distributed free to the ryots.

A complete list of agricultural publications issued in India during the period is given in Appendix XIII.

CHAPTER XII.

RECEIPTS AND EXPENDITURE OF THE AGRICULTURAL AND VETERINARY DEPARTMENTS.

The following tabular statements show the expenditure and receipts of the Agricultural and Veterinary Departments of the Imperial and Provincial Governments for the three years 1930-31 to 1932-33.

Agricultural Departments.

	1930-31		1931-32		1932-33	
	Expenditure	Receipts	Expenditure	Receipts	Expenditure	Receipts
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
Imperial Department of Agriculture.	15,50,062	4,79,113	11,89,001	3,71,470	9,09,599	2,84,416
Madras	20,29,559	2,28,196	17,73,165	2,09,536	16,90,668	2,02,372
Bombay Presidency (Proper) .	14,35,905	2,22,374	12,91,444	1,85,722	11,22,464	2,15,975
Sind	3,48,991	44,205	4,97,743	33,927	4,04,975	11,018
Bengal	10,76,453	1,14,932	10,55,945	1,11,975	9,90,970	91,235
United Provinces . . .	23,75,295	4,55,280	20,55,860	3,45,551	18,67,591	3,47,713
Punjab	26,74,386	6,64,332	20,46,479	4,97,230	18,17,637	4,56,206
Burma	9,76,659	95,069	7,74,136	1,15,384	7,75,829	1,05,233
Bihar and Orissa . . .	6,86,937	1,26,789	6,15,411	1,06,703	5,36,558	1,02,438
Central Provinces . . .	11,29,025	3,54,119	10,19,815	2,84,791	8,94,175	2,88,312
Assam	4,60,441	82,235	4,33,891	66,107	4,00,549	65,745
North-West Frontier Province .	79,996	26,868	71,075	20,690*	72,528	16,825†
Baluchistan	17,763	10,264	13,485	6,416	16,231	3,266
TOTAL .	1,48,41,472	29,27,368	1,28,42,450	23,55,502	1,14,99,774	21,90,754

* Excluding Rs. 12,000 due from contractors.

† Excluding Rs. 14,000 due from contractors.

Veterinary Departments.

	1930-31		1931-32		1932-33	
	Expenditure	Receipts	Expenditure	Receipts	Expenditure	Receipts
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
Madras	11,67,948	35,294	10,27,667	36,384	8,99,394	45,292
Bombay Presidency (Proper)	4,76,696	8,789	5,44,409	19,080	4,90,407	17,005
Sind	1,38,438		1,31,383		1,18,534	
Bengal	4,10,455	1,03,835	2,34,805	82,763	2,17,669	84,869
United Provinces	5,32,852	1,11,146	5,11,887	1,11,706	4,58,047	1,37,866
Punjab*	20,68,573	1,80,139	19,89,988	2,04,093	18,27,591	1,49,225
Burma	6,38,000	1,070	6,61,934	21,369	5,56,351	20,679
Bihar and Orissa	4,42,272	1,21,966	4,26,096	1,20,435	3,90,576	1,24,043
Central Provinces	4,25,880	1,637	3,87,588	1,563	3,80,419	1,695
Assam	1,81,667	1,098	1,70,434	955	1,73,737	1,032
North-West Frontier Province	78,869	4,686	82,677	4,512	89,156	4,500
Imperial Institute of Veterinary Research, Muktesar and its sub-station, Izatnagar.	8,29,409	12,00,381	6,47,026	10,20,021	6,34,456	9,22,805
TOTAL	73,91,059	17,70,041	68,15,894	16,22,881	62,36,337	15,09,011
Baluchistan	74,080	344	67,098	..	61,962	..
Coorg	17,020	62	14,658	193	19,540	300
Ajmere-Merwara	8,293	..	6,072	..	8,305	..
TOTAL	99,393	406	87,828	193	89,807	300
GRAND TOTAL	74,90,452	17,70,447	69,03,717	16,23,074	63,26,144	15,09,311

*Including breeding operations.

The above figures tell their own tale and merely epitomize the many references in the body of the report to the effect of financial stringency on agricultural development. Fortunately, the grants for research work made by the Imperial Council of Agricultural Research and the grants for cotton research and seed-distribution schemes made by the Indian Central Cotton Committee have done much to enable some progress to be made and have saved previous work from being wasted. The reports of provincial departments of agriculture and the local governments' resolutions on them state the value of this assistance in the clearest language. Fortunately, there are signs that the worst stage has been passed and that modest increases in the agricultural and veterinary departments' budgets are in sight in some provinces.

APPENDIX I

Areas under new and improved varieties of crops in India during 1931-32 and 1932-33

Name of Province	Name of crop	Area in acres								
		1930-31			1931-32			1932-33		
		Departmental	Natural spread	Total	Departmental	Natural spread	Total	Departmental	Natural spread	Total
(a) British India										
Madras	Paddy	19,832	272,646	292,478	23,644	375,848	399,492	37,968	526,411	564,379
	Cotton	86,865	213,707	300,572	85,545	255,441	340,986	75,684	275,706	351,390
	Sugarcane	240	21,080	21,321	995	24,226	25,221	6,547	18,253	24,800
	Miscellaneous	11,498	83,028	94,526	20,430	120,435	140,869	19,383	120,280	139,663
	Cotton—									
	1027 A. L. F.	239,160	..	..	230,652	..	230,652	239,436	..	239,436
	Neglectum Roseum	3,076	..	..	1,604	32,400	34,004	735	38,195	38,930
	Banilla	22,100	..	..	43,624	106,087	149,711	5,310	123,600	128,910
	Gadag No. 1	78,600	..	..	125,596	..	125,596	22,514	31,970	54,484
	Jayawant	17,210	..	..	118,180	200	118,380	55,109	53,486	108,590
	Wagad No. 6	150	..	..	162	60	222	51	150	201
	TOTAL COTTON	410,296	..	..	519,818	138,747	658,565	323,155	247,396	570,551
Bombay Presidency (proper)	Groundnut	5,694	..	..	262	731,719	731,981	254	848,549	848,803
	Sugarcane	142	..	..	43	336	379	482	4,640	5,122
	Bajra	1,755	..	..	2,615	2,075	4,690	872	5,235	6,107

	Wheat (Pusa 4, etc.)	11,259	..	..	10,951	19,600	30,551	868	19,658	20,526
	Paddy (Kolamba rice)	3,447	..	..	1,215	32,391	33,606	1,726	84,867	86,593
	Tobacco (Strains 6 & 28)	..	..	..	1,536	1,090	2,626	566	2,548	3,114
	Nagli	..	..	..	221	290	511	260	975	1,235
	Guavas and figs	1,534	..	..	3	..	3	3	..	3
	Grapes	..	..	..	..	..	..	1	..	1
	Other fruits	..	..	..	105	2,260	2,365	446	2,706	3,152
	Cotton—									
	4F, 285F	1,264	57,751	59,013	3,030	56,970	60,000	3,088	95,560	98,648
	Deshi 27 W. N.	4,395	26,615	31,010	3,326	98,000	101,326	5,427	104,600	110,027
	TOTAL COTTON	5,659	84,366	90,023	6,356	154,970	161,326	8,515	200,160	208,675
Sind										
	Wheat (Pusa 12, A. T. 38, Punjab 11, Punjab 8-A, Pusa 114, C. Ph. 47, H. S. W. 9-W.).	1,657	84,395	86,052	1,063	102,184	103,247	3,073	170,864	173,937
	Paddy (Kangni, Prong and Jajai).	1,363	1,527	2,890	290	2,710	3,000	588	8,300	8,888
	Jowar	410	..	410	151	485	636	135	565	700
	Paddy (Indrasil, Dudsar, Jhingasall, Kataktara, Charnak and Surajmukhi).	5,676	217,557	223,233	15,948	268,245	284,193	10,945	292,572	303,517
	Jute	22,346	1,019,156	1,041,502	8,200	920,670	928,870	4,630	953,081	957,711
Bengal	Sugarcane	320*	67,934	68,254*	1,411	65,270	66,681	3,529	94,643	98,172
	Other crops	552	17,264	17,816	188	2,104	2,292	321	3,815	4,136
	Wheat	150,000	650,000	1,800,000	140,000	1,800,000	1,940,000	156,000	1,940,000	2,096,000
	Cotton	30,000	225,000	255,000	16,000	255,000	271,000	34,000	271,000	305,000
United Provincee	Sugarcane	27,000	651,000	678,000	241,000	1,164,000	1,188,000	50,000	1,240,000	1,290,000

*Revised.

Areas under new and improved varieties of crops in India during 1931-32 and 1932-33—contd.

Name of Province	Name of crop	Area in acres								
		1930-31			1931-32			1932-33		
		Departmental	Natural spread	Total	Departmental	Natural spread	Total	Departmental	Natural spread	Total
					(a) British India—*contd.*					
United Provinces—*contd.*	Barley	10,000	24,000	34,000	5,000	34,000	39,000	6,000	39,000	45,000
	Gram	26,000	50,000	76,000	11,000	76,000	87,000	12,000	87,000	99,000
	Miscellaneous	52,000	82,000	134,000	9,000	134,000	143,000	70,000	143,000	213,000
Punjab	American cottons—									
	4-F.	..	..	798,400	108,624	560,300	668,920	121,650	623,810	745,460
	289-F.	..	..	36,900	3,751	24,626	28,380	4,300	26,500	30,800
	Improved Desi cottons—									
	Indicum (Mollisoni)	..	..	515,700	78,312	387,020	465,330	62,780	426,720	489,500
	Neglectum	..	..	99,200	550	71,193	71,740	2,220	61,780	64,000
	Other improved varieties	..	..	..	..	..	..	120	25,580	25,700
	TOTAL COTTON	..	..	1,450,200	191,237	1,043,139	1,234,370	191,070	1,164,390	1,355,460
	Wheats—									
	8-A	..	..	2,292,400	58,760	2,490,300	2,549,060	43,600	2,350,600	2,394,200
	Punjab 11	..	..	75,650	475	58,675	59,150	..	63,500	63,500
	Improved varieties	..	..	79,950	2,410	161,260	163,670	3,200	54,400	57,600
	TOTAL WHEAT	..	..	2,448,000	61,645	2,710,235	2,771,880	46,800	2,468,500	2,515,300

Burma	Improved sugarcane	..	..	104,400	5,766	137,074	142,840	2,030	172,740	174,770
	Paddy	74,813*	361,991*	436,804	78,740	410,291	489,031	68,246	600,502	668,748
	Sugarcane	22*	173*	195*	32	1,700	1,732	64	3,278	3,342
	Gram	1,439	124,575	145,286	1,070	117,966	138,751	1,180	145,629	146,809
	Sesamum	..	..	4,679	..	..	5,056	3,253	4,777	8,030
	Cotton	4,890	4,500	9,390	4,540	5,000	9,540	2,076	750	2,826
	Groundnut	469	2,050	20,970	306	18,786	19,092	283	25,316	25,599
	Butter beans	173	234	407	2,158	995	3,153	1,133	7,926	9,059
	Wheat	5	8,484	8,489	26	15,700	15,726	71	13,500	13,571
	Pesseinngon	..	..	..	..	..	..	244	1,856	2,100
	Saccoline *jowar*	10	320	330	..	380	380	784	610	1,394
	Paddy—									
	Dahia	950	7,094	8,044	4,547	9,083	13,630	660	12,105	12,765
	Cuttack Nos. 1, 2, 3 and 4, Buromal, Kankesal, Rais 1, Badshabhog, etc.	145	6,945	7,090	534	8,072	8,606	362	8,179	8,541
	TOTAL PADDY	1,095	14,039	15,134	5,081	17,155	22,236	1,022	20,284	21,306
Bihar and Orissa	Sugarcane (Co. 213, Co. 205).	336	101,782	102,118	55,529	139,176	194,705	708	229,317	230,025
	Groundnut	715	1,667	2,382	335	2,295	2,630	147	2,262	2,409
	Wheat (Pusa 52, 12)	1,981	21,225	23,206	7,892	27,954	35,846	3,035	34,872	37,907
	Gram (Sabour 4, 17)	28	889	917	142	1,402	1,544	202	2,024	2,226
	Tobacco (Pusa 28)	..	500	500	14	700	714	10	839	849
	Miscellaneous (Potatoes, Onions, *Juar*, Maize, Rahar, Pea, Ginger, *Mung*, *Dhaincha*, Linseed, Jute).	266	976	1,242	233	6,314	6,547	1,732	10,877	12,609

* Revised.

Areas under new and improved varieties of crops in India during 1931-32 and 1932-33—concld.

Name of Province	Name of crop	Area in acres								
		1930-31			1931-32			1932-33		
		Departmental	Natural spread	Total	Departmental	Natural spread	Total	Departmental	Natural spread	Total
(a) British India—*concld.*										
Central Provinces	Wheat	..	..	377,372	..	..	427,992	..	..	458,932
	Rice	..	..	254,781	..	..	336,267	..	..	400,281
	Cotton	..	..	683,695	..	..	558,169	..	..	896,765
	Juar	..	..	153,282	..	..	117,192	..	..	137,948
	Groundnut	..	..	115,831	..	..	127,393	..	..	128,242
	Other crops	..	..	37,343	..	..	25,519	..	..	80,043
Assam	Rice	1,950	17,000	18,950	2,240	20,635	22,875	4,943	31,898	36,841
	Sugarcane	43	7,000	7,043	21	7,557	7,578	23	8,828	8,851
	Potatoes	.145	13,130	13,275	144	13,350	13,494	263	13,963	14,226
	Jute	1,320	62,000	63,320	593	41,261	41,854	621	44,469	45,090
North-West Frontier Province.		..	..	..	..	..	..	..	..	..
(b) Indan States										
Hyderabad	Cotton (Gaorani, Gadag No. 1, Banilla, Jayawant).	114,100	..	114,100	197,213	..	197,213	194,675	..	194,675
	Groundnut	340	..	340	543	..	543	1,867	..	1,867
	Sugarcane	26	..	26	34	..	34	45	..	45
	Miscellaneous	..	..	..	..	..	..	369	..	369

Mysore	*Ragi*	35,441	98,225	133,666	13,520	138,470	151,990	9,899	166,668	176,567
	Paddy	3,677	34,482	38,159	6,000	40,557	47,247	9,883	41,536	51,419
	Sugarcane	1,781	4,632	6,413	592	3,154	3,746	2,327	5,811	8,138
	Groundnut	711	105,295	106,006	570	46,068	46,638	551	48,152	48,703
	Cotton	11,043	12,120	23,163	18,580	22,320	40,900	19,603	32,045	51,648
	Miscellaneous manures, (Green Sann-hemp, potato, wheat, etc.).	362	12,434	12,796	255	6,173	6,428	584	6,778	7,362
Travancore	Paddy	261	1,000	1,261	300	580	880	440	Not available	440
Baroda	Cotton	6,807	..	6,807	9,987	9,185	19,172	13,156	16,807	29,963
	Paddy	56	105	161	18	8,385	8,403	27	8,395	8,422
	Jowar	..	..	..	..	..	..	10	50	60
	Sugarcane	..	..	..	2	..	2	..	..	..
	Wheat	35	..	35	57	2,547	2,604	93	6,002	6,149

* Revised.

APPENDIX II

List of Agricultural Stations in India during 1931-32 and 1932-33

Province	Agricultural Stations	Area in acres	Officer in Immediate charge	Supervising Officer	REMARKS
Imperial Department of Agriculture in India.	Pusa	741-753*	Assistant Agriculturist	Imperial Agriculturist	Imperial Institute of Agricultural Research. * Cultivated area.
		143	Farm Superintendent	Imperial Economic Botanist	Botanical Sub-station financed by Imperial Council of Agricultural Research.
	Karnal	30	Assistant	Sugarcane Expert	Sugarcane Sub-station financed by the Imperial Council of Agricultural Research.
		1,981	Superintendent	Imperial Dairy Expert	Cattle-Breeding Farm.
	Bangalore	812	Ditto	Ditto	Dairy Farm.
	Wellington	151	Supervisor	Ditto	Milk Department.
	Coimbatore	90	Farm Manager	Sugarcane Expert	Cane-Breeding Station.
Madras	Anakapalle	104	Superintendent	Deputy Director of Agriculture, I Circle, Vizagapatam.	
	Samalkota	57	Farm Manager	Ditto.	
	Guntur	150	Ditto	Deputy Director of Agriculture, II Circle, Guntur.	
	Hagari	225	Ditto	Deputy Director of Agriculture, III Circle, Bellary.	
	Nandyal	88	Ditto	Ditto.	
	Kalahasti	9	Ditto	Deputy Director of Agriculture, IV Circle, St. Thomas Mount.	
	Palur	52	Ditto	Ditto.	
	Aduthurai	50	Superintendent	Deputy Director of Agriculture, V Circle, Trichinopoly.	

	Coimbatore	400	Ditto	Principal, Agricultural College, Coimbatore.	
	Koilpatti	140	Ditto	Deputy Director of Agriculture, VI Circle, Madura.	
	Tallparamba	86	Farm Manager	Deputy Director of Agriculture, VII Circle, Tellicherry.	
	Nanjanad	160	Superintendent	Deputy Director of Agriculture, VIII Circle, Coimbatore.	
	Berhampur	33	Ditto	Paddy Specialist, Coimbatore.	
	Marutera	50	Ditto	Ditto.	
	Pattambi	82	Ditto	Ditto.	
	Palakuppam	16	Farm Manager	Oil-Seeds Specialist, Coimbatore.	
	Kasargod and Nileshwar	178	Ditto	Ditto.	
	Pomological Station, Coonoor	12	Ditto	Curator, Government Botanic Gardens, Ootacamund.	
	Hosur	1,660	Superintendent	Deputy Director of Agriculture, Live-Stock, Hosur.	
	Karjat	6	Ditto	Crop Botanist to Government, Karjat.	Rice-Breeding Station.
	Niphad	12	Ditto	Ditto	Cereal Breeding Station.
	Poona Agricultural College Farm	275	Ditto	Professor of Agriculture, Poona	
	Kirkee	362	Manager	Ditto	Agricultural College Dairy.
	Charrodi	2,278	Ditto	Live-Stock Expert to Government.	Poona Cattle Farm.
Bombay Presidency (proper)	Bankapur	(1) 96	Ditto	Ditto	(1) Farm Area.
		(2) 152	Ditto	Ditto	(2) Grazing area at Kalasgeri attached to the Farm.
	Ganeshkhind Botanical Gardens, Kirkee	80	Superintendent	Horticulturist to Government, Poona.	
	Modibag	12	Ditto	Ditto.	
	Jalgaon	204	Ditto	Deputy Director of Agriculture, N. C. D., Nasik.	
	Bhadgaon	209	Ditto	Ditto	Cotton Seed Farm financed by the Indian Central Cotton Committee.

List of Agricultural Stations in India during 1931-32 and 1932-33—contd.

Province	Agricultural Stations	Area in acres	Officer in Immediate charge	Supervising Officer	Remarks
Bombay Presidency (proper) —*contd.*	Dhulia	28	Head Master, Dhulia School	Deputy Director of Agriculture, N. C. D., Nasik.	
	Sangri	49	Manager	Ditto.	
	Karjat	15	Rice Specialist	Ditto.	
	Dharwar	146	Superintendent	Deputy Director of Agriculture, S. D., Dharwar.	
	Gokak	62	Ditto	Ditto.	
	Mugad	9	Rice Breeder	Ditto.	
	Kumpta	68	Superintendent	Ditto.	
	Tegur	370	Fieldman	Ditto.	
	Gadag	55	Manager	Ditto	Cotton Seed Farm financed by the Indian Central Cotton Committee.
	Surat	294	Superintendent	Deputy Director of Agriculture, Gujarat, Surat.	Research and experiments in cotton, *jowar* breeding, cultural and manurial experiments on cotton and *jowar*.
	Nadiad	11	Tobacco Breeder	Ditto	Tobacco and *bajri* research station.
	Broach	18	Superintendent	Ditto	Breeding cotton, *jowar* and wheat types.
	Dohad	68	Ditto	Ditto	Improving staple crops of maize, wheat and groundnut and multiplying seeds for distribution.
	Viramgaon	18	Cotton Breeder, North Gujarat.	Ditto	Cotton and *jowar* breeding station.
	Kopargaon	25	Superintendent	Deputy Director of Agriculture, S. C. D., Poona.	Sugarcane confirmation station.
	Ratnagiri	94	Ditto	Ditto	Rice and Nagli breeding farm.

	Mohol	55	Ditto	Ditto	This farm is maintained for testing and showing methods of dry farming.
	Pedegaon	104	Principal Agricultural Officer	Director of Agriculture, Poona	A sugarcane research station financed by the Imperial Council of Agricultural Research.
Bombay Presidency (Sind)	Government Auxiliary Farm, Padidan	300	Manager	Chief Agricultural Officer in Sind	
	Government Auxiliary Farm, Oderolal	365	Ditto	Ditto.	
	Government Auxiliary Farm, Dadu	583	Ditto	Ditto.	
	Government Auxiliary Farm, Lundo	448	Ditto	Ditto.	
	Government Auxiliary Farm, Nasirabad	297	Ditto	Ditto.	
	Government Auxiliary Farm, Shahdadkote.	180	Ditto	Ditto.	
	Government Seed Farm, Mirpurkhas	200	Cotton Breeder and Superintendent	Ditto.	
	Government Fruit Farm, Mirpurkhas	60	Horticulturist	Ditto.	
	Agricultural Station, Larkana	61	Superintendent	Ditto.	
	Research Station, Sakrand	234	Officer in charge and Agricultural Chemist.	Ditto.	
Bengal	Chinsurah	210	Farm Superintendent, Chinsurah.	Deputy Director of Agriculture, Western Circle.	
	Berhampur	44	District Agricultural Officer, Berhampur.	Ditto.	
	Bankura	29	District Agricultural Officer, Bankura.	Ditto.	
	Suri	33	District Agricultural Officer, Birbhum, Suri.	Ditto.	
	Krishnagar	53	District Agricultural Officer, Nadia.	Ditto.	
	Gosaba (24-Parganas)	8	Agricultural Officer, Gosaba	Ditto.	
	Jessore Khasmahal Farm	5	District Agricultural Officer, Jessore.	Ditto.	
	Burdwan	35	District Agricultural Officer, Burdwan.	Ditto.	

List of Agricultural Stations in India during 1931-32 and 1932-33—contd.

Province	Agricultural Stations	Area in acres	Officer in Immediate charge	Supervising Officer	REMARKS
Bengal—*contd.*	Rajshahi	63	Superintendent, Rajshahi Farm.	Deputy Director of Agriculture, Northern Circle.	
	Pabna	19	District Agricultural Officer, Pabna.	Ditto.	
	Bogra	23	District Agricultural Officer, Bogra.	Ditto.	
	Bogra Branch Farm	7	Ditto	Ditto.	
	Malda	16	District Agricultural Officer, Malda.	Ditto.	
	Dinajpur	24	District Agricultural Officer, Dinajpur.	Ditto.	
	Rangpur Demonstration Farm	19	District Agricultural Officer, Rangpur.	Ditto.	
	Mainaguri	25	District Agricultural Officer, Mainaguri.	Ditto.	
	Rangpur Cattle Farm	333	Superintendent, Cattle Farm, Rangpur.	Live Stock Expert, Bengal.	
	Khanjaripur	8	Collector, Bogra	....	
	Government Tobacco Farm, Rangpur	52	Superintendent, Tobacco Farm.	Agricultural Chemist, Bengal.	
	Dacca Central Farm	354	Chief Superintendent	Deputy Director of Agriculture, Eastern Circle.	
	Jaidebpur Court of Wards Farm	11	Agricultural Demonstrator	Deputy Director of Agriculture, Eastern Circle, and District Agricultural Officer, Dacca.	
	Mymensingh Farm	20	District Agricultural Officer, Mymensingh.	Deputy Director of Agriculture, Eastern Circle.	
	Jamalpur Farm	35	District Agricultural Officer, Jamalpur.	Ditto.	
	Kishoreganj Farm	83	District Agricultural Officer, Kishoreganj.	Ditto.	

Dhanbari Farm	7	Agricultural Demonstrator	Deputy Director of Agriculture, Eastern Circle and District Agricultural Officer, Kishoreganj.
Gayhatta C. W. Farm . . .	4	Ditto .	Deputy Director of Agriculture, Eastern Circle and District Agricultural Officer, Jamalpur.
Baratia Private Farm . . .	8	Ditto .	Ditto.
Faridpur Farm	20	District Agricultural Officer, Faridpur.	Deputy Director of Agriculture, Eastern Circle.
Rajbari Farm	10	Agricultural Demonstrator, Rajbari.	Ditto.
Barisal Farm	20	District Agricultural Officer, Barisal.	Ditto.
Rangamati Farm	51	District Agricultural Officer, Rangamati.	Assistant Director of Agriculture, Bengal.
Charbadna Farm	67	Agricultural Demonstrator and District Agricultural Officer, Barisal.	Deputy Director of Agriculture, Eastern Circle and District Agricultural Officer, Barisal.
Chandra Mohan Farm . . .	14	Agricultural Demonstrator	Ditto.
Amtali	1	Ditto .	Ditto.
Bargana Farm	3	Ditto .	Ditto.
Khepupara Colonisation Farm . .	6	Ditto .	Ditto.
Daulat Khan C. W. Farm, Fazirchar .	..	Ditto .	Ditto.
Comilla Farm	20	District Agricultural Officer, Comilla.	Deputy Director of Agriculture, Eastern Circle.
Brahmanbaria Private Farm . .	5	Agricultural Demonstrator	Deputy Director of Agriculture, Eastern Circle and District Agricultural Officer, Comilla.
Char Nilkamal Khasmahal Farm .	2	Ditto .	Ditto.
Durgapur H. E. School Farm . .	5	Agricultural teacher attached to the school.	Deputy Director of Agriculture, Eastern Circle and District Agricultural Officer, Chittagong.
Kalimpong Farm	75	Superintendent of Agriculture, Kalimpong.	Assistant Director of Agriculture, Bengal.

List of Agricultural Stations in India during 1931-32 and 1932-33—contd.

Province	Agricultural Stations	Area in acres	Officer in Immediate charge	Supervising Officer	Remarks
United Provinces	Shahjahanpur	165	Superintendent	Economic Botanist (Sugarcane and Paddy) to Government, U. P.	
	Nagina (Bijnor)	77	Research Specialist	Ditto.	
	Budaun	20	Overseer	Deputy Director of Agriculture, Rohilkhand and Kumaon Circle, Bareilly.	
	Nawabganj (Bareilly)	120	Ditto	Ditto.	
	Jeolikote	51	Ditto	Ditto.	
	Tarikhet	17	Ditto	Ditto.	
	Atarra (Banda)	171	Ditto	Divisional Superintendent of Agriculture, Bundelkhand Circle.	
	Bela Tal (Harnipur)	30	Ditto	Ditto.	
	Etawah	61	Ditto	Ditto.	
	Bichpuri (Agra)	100	Superintendent	Ditto.	
	Fyzabad	206	Overseer	Deputy Director of Agriculture, Eastern Circle, Partabgarh.	
	Partabgarh	90	Superintendent	Assistant Deputy Director of Agriculture, Eastern Circle.	
	Benares	78	Ditto	Divisional Superintendent of Agriculture, Eastern Circle.	
	Kalai (Aligarh)	143	Ditto	Deputy Director of Agriculture, Western Circle.	
	Bulandshahr	25	Inspector	Ditto.	
	Muzaffarnagar	101	Ditto	Assistant Deputy Director of Agriculture, Western Circle.	
	Meerut	76	Ditto	Ditto.	
	Mainpuri	53	Overseer	Divisional Supervisor of Agriculture, Western Circle.	

Punjab	Gorakhpur	110	Ditto	Deputy Director of Agriculture, North-Eastern Circle, Gorakhpur.	
	Bahraich	102	Ditto	Divisional Superintendent, North-Eastern Circle.	
	Kallanpur (Cawnpore)	263	Ditto	Deputy Director of Agriculture, Sarda Circle.	
	Handoi	55	Ditto	Divisional Superintendent of Agriculture, Sarda Circle.	
	Palhai (Bara Banki)	80	Ditto	Assistant Deputy Director of Agriculture, Sarda Circle.	
	Haidergarh (Bara Banki)	16	Ditto	Ditto.	
	Turner (Rae Bareily)	12	Ditto	Ditto.	
	Unao	39	Ditto	Ditto.	
	Lyallpur Agricultural Station	425	Agricultural Assistant	Deputy Director of Agriculture, Lyallpur.	Experimental Farm.
	Lyallpur Students Farm	82	Assistant Professor of Agriculture.	Professor of Agriculture	For practical training.
	Lyallpur Botanical Farm and Fruit Garden.	113	Associate Professor of Botany.	Associate Professor of Botany, Punjab Agricultural College, Lyallpur.	Botanical experiments.
	Risalewala	810	Agricultural Assistant	Deputy Director of Agriculture, Lyallpur.	Mainly a seed Farm.
	Cotton Research Botanists' Farm, Risalewala.	230	Cotton Research Botanist	Cotton Research Botanist, Lyallpur.	Cotton experiments.
	Cotton Research Botanists' Farm, Lyallpur.	18	Ditto	Ditto.	
	Jhang Farm	200	Agricultural Assistant	Deputy Director of Agriculture, Lyallpur.	District Farm.
	Kalashah Kaku Rice Farm	381	Assistant Cerealist	Ditto	Rice Breeding Station.
	Montgomery Agricultural Station	681	Agricultural Assistant	Deputy Director of Agriculture, Montgomery.	Experimental Farm.
	Shergarh Farm	1,108	Ditto	Ditto	Seed Farm.
	Fatna Farm	528	Ditto	Ditto	Ditto.
	Multan Farm	528	Ditto	Ditto	Ditto.
	Vihari Farm	500	Ditto	Ditto	Ditto.

List of Agricultural Stations in India during 1931-32 and 1932-33—contd.

Province	Agricultural Stations	Area in acres	Officer in Immediate charge	Supervising Officer	REMARKS
Punjab—*contd.*	Gurdaspur Agricultural Station	263	Agriculture Assistant	Deputy Director of Agriculture, Gurdaspur.	Experimental Farm.
	Beas Farm	36	Ditto	Ditto	District Farm.
	Attari Farm	101	Ditto	Ditto	Ditto.
	Gujranwala Farm	107	Ditto	Ditto	Ditto.
	Rawalpindi Agricultural Station	252	Ditto	Deputy Director of Agriculture, Rawalpindi.	Experimental Station.
	Campbellpur Farm	100	Ditto	Ditto	District Farm.
	Gujrat Farm	45	Ditto	Ditto	Ditto.
	Chillianwala Seed Farm	250	Ditto	Ditto	Seed Farm.
	Sargodha Old Seed Farm	155	Ditto	Ditto	Ditto.
	Sargodha New Seed Farm	492	Ditto	Ditto	Ditto.
	Mianwali	207	Ditto	Ditto	District Farm.
	Hansi Agricultural Station	589	Ditto	Deputy Director of Agriculture, Hansi.	Experimental Station.
	Sirsa Seed Farm	400	Ditto	Ditto	Seed Farm.
	Ferozepur Farm	100	Ditto	Ditto	District Farm.
	Gurgaon Farm	100	Ditto	Ditto	Ditto.
	Rohtak Farm	100	Ditto	Ditto	Ditto.
	Ambala Farm	100	Ditto	Ditto	Ditto.
	Karnal Farm	100	Ditto	Ditto	Ditto.
	Ludhiana Farm	54	Ditto	Deputy Director of Agriculture, Jullundur.	Ditto.
	Kangra Plot	10	Ditto	Ditto	Agricultural plot.
	Jullundur Agricultural Station	119	Ditto	Ditto	Experimental Farm.
	Hmawbi	456	Farm Superintendent	Deputy Director of Agriculture, Southern Circle.	

Burma	Mandalay	630	Ditto	Professor of Agriculture.	
	Kambalu	534	Ditto	Deputy Director of Agriculture, Northern Circle, Mandalay.	
	Mahlaing	254	Ditto	Deputy Director of Agriculture, Myingyan Circle, Meiktila.	
	Pyinmana	55	Ditto	Deputy Director of Agriculture, Eastern Circle, Pyinmana.	
	Tatkon	106	Ditto	Ditto.	
	Allanmyo	144	Ditto	Deputy Director of Agriculture, West Central Circle, Magwe.	
	Sagaing	11	Ditto	Ditto.	
	Myaungmya	92	Ditto	Deputy Director of Agriculture, Irrawaddy Circle, Bassein.	
	Mudon	88	Ditto	Deputy Director of Agriculture, Tenasserim Circle, Moulmein.	
	Akyab	138	Ditto	Deputy Director of Agriculture, Arakan Circle, Akyab.	
	Kyaukpyu	23	Ditto	Ditto.	
	Pankkaung	16	Ditto	Entomologist, Mandalay.	
Bihar and Orissa	Cuttack	150	Manager	....	
	Khurda	31	Overseer	....	
	Balasore	75	Ditto	Assistant Director of Agriculture, in-charge of Orissa Range.	
	Angul	47	Ditto	....	
	Puri	42	Ditto	....	
	Kujang*	39*	Ditto	* Of which 26·4 were presented by the Maharaja of Burdwan.	
	Sambalpur	32	Ditto	....	
	Sepaya	379	Manager	....	
	Siwan	25	Overseer	....	
	Darbhanga	26	Ditto	Deputy Director of Agriculture, North Bihar Range.	Tournament Rust Farm.
	Byrnah	316	Farm Manager	Manager, Bettiah Raj Court of Wards Farm.	

List of Agricultural Stations in India during 1931-32 and 1932-33—contd.

Province	Agricultural Stations	Area in acres	Officer in Immediate charge	Supervising Officer	REMARKS
Bihar and Orissa—*contd.*	Sabour	190	Assistant Director of Agriculture.	....	
	Jamui	38	Overseer	....	
	Banka	26	Ditto	....	
	Patna	200	Manager	....	
	Gaya	95	Overseer	....	
	Nawadah	83	Ditto	Assistant Director of Agriculture, in-charge South Bihar Range.	
	Pikram Gunj	24	Ditto	....	
	Siris	35	Ditto	....	
	Kanke	340	Manager	....	
	Netarhat	193	Overseer	....	
	Purulia	52	Ditto	Deputy Director of Agriculture, Chhota Nagpur.	
	Chionki	32	Ditto	....	
	Chaibassa	38	Ditto	....	
	Experimental Farm, Akola	272	Superintendent	Economic Botanist for Cotton, C. P., Nagpur.	
	Experimental Farm, Chhindwara	69	Ditto	Deputy Director of Agriculture	
	Powarkhera (Hoshangabad)	528	Ditto	Ditto.	
	Adhartal (Jubbulpore)	299	Ditto	Ditto.	
	Nagpur	286	Extra Assistant Director	Principal, Agricultural College, Nagpur.	
	Labhandi (Raipur)	229	Ditto	Deputy Director of Agriculture	
	Tharsa	116	Ditto	Ditto.	
	Demonstration Farm, Waraseoni	63*	Superintendent	Ditto	* Cropped area.

Central Provinces	Demonstration Farm, Betul	160	Ditto	Ditto.	
	Demonstration Farm, Bilaspur	253	Ditto	Ditto.	
	Demonstration Farm, Basim	110	Ditto	Ditto.	
	Demonstration Farm, Buldana	135	Ditto	Ditto.	
	Sindewahi Demonstration Farm	140*	Ditto	Ditto	* Cropped area.
	Demonstration Farm, Drug	281	Ditto	Ditto.	
	Demonstration Fram, Damoh	152	Ditto	Ditto.	
	Demonstration Farm, Khandwa	177	Ditto	Ditto.	
	Chand Khuri (Raipur), Demonstration Farm.	111*	Ditto	Ditto.	
	Demonstration Farm, Seoni	170	Ditto	Ditto.	
	Demonstration Farm, Yeotmal	106	Ditto	Ditto.	
	Demonstration Farm, Saugor	161	Ditto	Ditto.	
	Demonstration Farm, Narsinghpur	89	Ditto	Ditto.	
	Cattle Breeding Farm, Drug	..	Ditto	Ditto	This Farm is attached to the Demonstration Farm, Drug.
	Cattle Breeding Farm and Dairy, Ellichpur.	300	Ditto	Ditto.	
	Cattle Breeding Farm, Powarkhera	..	Ditto	Ditto	Attached to the Experimental Farm, Powarkhera.
	Cattle Breeding Farm, Adhartal	339	Ditto	Ditto.	
	Cattle Breeding Farm and Dairy, Telinkheri.	1,000	Ditto	Ditto.	
	Cattle Breeding Farm, Chandkhuri	..	Ditto	Ditto	Attached to the Demonstration Farm, Chandkhuri.
	Cattle Breeding Farm, Khandwa	..	Ditto	Ditto	Attached to the Demonstration Farm, Khandwa.
	Cattle Breeding Farm, Garhi	1,617	Ditto	Ditto.	
	Cattle Breeding Farm, Pendra	2,500	Ditto	Ditto.	
	Cattle Breeding Farm, Bod	2,906	Ditto	Ditto.	
	Cattle Breeding Farm, Borgaon	379	Ditto	Ditto.	
	Cattle Breeding Farm, Bilaspur	..	Ditto	Ditto	Attached to the Demonstration Farm, Bilaspur.

List of Agricultural Stations in India during 1931-32 and 1932-33—contd.

Province	Agricultural Stations	Area in acres	Officer in Immediate charge	Supervising Officer	Remarks
Assam	Upper Shillong	521	Farm Manager	Live-stock and Dairy Expert, Assam.	Cattle breeding, potato and fodder crops.
	Khanapara	197	Ditto	Ditto	Cattle breeding and fodder crops.
	Jorhat	59	Ditto	Deputy Director of Agriculture, Upper Assam Valley.	Sugarcane.
	Titabar	125	Ditto	Ditto	Rice.
	Karim Gunj	80	Ditto	Deputy Director of Agriculture, Surma Valley.	Do.
	Sylhet	210	Ditto	Live-stock and Dairy Expert, Assam.	Cattle breeding and fodder crops.
	Shillong Fruit Garden	63	Fruit Inspector, Assam	Director of Agriculture, Assam	Fruit Culture.
North-West Frontier Province.	Tarnab (near Taru Jabba).	200	Agricultural Officer	Agricultural Officer.	
	Haripur	16	Agricultural Assistant	Ditto.	
Hyderabad-Deccan	Government Main Farm, Himayatsagar	299	Superintendent, Government Main Farm.	Deputy Director of Agriculture, West Talingana.	
	Government Main Farm, Parbhani	264	Ditto	Deputy Director of Agriculture, Marhatwara Division.	
	Cattle Breeding Farm, Himayatsagar.	600	Superintendent, Cattle Breeding Farm.	Deputy Director of Agriculture, West Telingana.	
	Experimental Farm, Nizamsagar	6	Superintendent, Nizamsagar Farm.	Ditto.	
	Demonstration Farm, Mahbubnagar	76	Superintendent, Mahbubnagar Farm.	Ditto.	
	Experimental Farm, Sangareddi	101	Superintendent, Sangareddi Farm.	Ditto.	
	Demonstration Farm, Alir	63	Superintendent, Alir Farm	Deputy Director of Agriculture, East Telingana.	

Mysore	Poultry Farm, Himayatsagar	Suitable plot reserved on the Main Farm, Himayatsagar.	Superintendent	Deputy Director of Agriculture, West Telingana.
	1. The Irwin Canal Farm	600	Ditto	Agricultural Chemist.
	2. Government Experimental Farm, Hiriyour.	21-36	Farm Manager	Director of Agriculture.
	3. The Jeevanarayanakatte Farm, Mysore City.	2¼	Agricultural Inspector	Assistant Director of Agriculture, Mysore.
	4. Cattle Breeding Station, Ajjampur	800	Manager	Live-stock Expert.
	Cattle Breeding Sub-station, Basur	2,269-38	Ditto	Ditto.
	Sheep Farm, Ajjampur	..	Ditto	Ditto.
	Yellachihalli Sheep Farm, Yelwal Post, Mysore.	500	Ditto	Ditto.
	Hebbal Dairy and Sheep Farm, Bangalore.	5	Ditto	Ditto.
	5. Kodihalli Farm, Mandya	297	Farm Manager	Assistant Director of Agriculture, Mandya Circle.
	Mallegere Farm	192	Ditto	Ditto.
	Satnur Farm	295	Ditto	Ditto.
	6. Government Coffee Experimental Station, Balehonnur.	290 (about 110 acres under crop.)	Ditto	Assistant Director, Chikmagalur.
	7. Marthur Farm	66	Ditto	Assistant Director, Shimoga Circle.
	8. Nagenhalli Paddy Breeding Station, Mysore.	45	Junior Assistant Botanist	Economic Botanist.
	9. Kar Ragi Breeding Station, Hunsur	24	Ditto	Ditto.
	10. Government Experimental Farm (Botanical Section).	37-5	Ditto	Ditto.
	11. Government Experimental Farm, Hebbal.	100	Farm Manager	Ditto.

List of Agricultural Stations in India during 1931-32 and 1932-33—concld.

Province	Agricultural Stations	Area in acres	Officer in Immediate charge	Supervising Officer	REMARKS
Travancore	Fruit Farm, Cape	16	Agricultural Sub-Inspector	Director of Agriculture.	
	Paddy Farm, Nagercoil	40	Agricultural Inspector	Ditto.	
	Cattle Farm, Trivandrum	100	Ditto	Ditto.	
	Experimental Farm, Kottara Kara	100	Head Master, Agricultural School.	Ditto.	
	Demonstration Farm, Shencotta	40	Agricultural Inspector, II Grade.	Agricultural Inspector, I Grade	
	Pepper Farm, Koni	150	Ditto	Ditto.	
	Coconut Farm, Cochira	4	Agricultural Demonstrator	Ditto.	
	Coconut Farm, Alleppey	9	Ditto	Agricultural Inspector.	
	Demonstration Farm, Vaikon	5	Agricultural Inspector	Director of Agriculture.	
	Demonstration Farm, Alwaye	13	Agricultural Sub-Inspector	Ditto.	
Baroda	Agricultural Experimental Station, Baroda.	84	Superintendent	Deputy Director of Agriculture, for Baroda District.	
	Agricultural Experimental Station, Jagodan.	18	Ditto	Director of Agriculture.	
	Agricultural Experimental Station, Amreli.	40	Ditto	Ditto.	
Gowalior	Gwalior	265	Farm Manager	Deputy Administrative Officer, Agricultural Section, Gwalior Division.	
	Ujjain	240	Ditto	Deputy Administrative Officer, Agricultural Section, Malwa Division.	
Bhopal	Nabi Bagh	150	Senior Agricultural Assistant	Director of Agriculture	Combined Demonstration and Seed Farm.
Patiala	Bhupindra Agricultural Farm	100	....	Ditto.	

APPENDIX III

Staffs of Provincial and State Departments of Agriculture in India during 1931-32 and 1932-33

Province	RESEARCH AND TEACHING STAFF											
	SUPERIOR SERVICE				PROVINCIAL SERVICE				SUBORDINATE SERVICE			
	Sanctioned cadre		Filled substantively		Sanctioned cadre		Filled substantively		Sanctioned cadre		Filled substantively	
	1931-32	1932-33	1931-32	1932-33	1931-32	1932-33	1931-32	1932-33	1931-32	1932-33	1931-32	1932-33
(a) British India												
Madras	6	6	5	5	19	19	19	19	112	109	98	96
Bombay—												
Presidency Proper	5	5	5	5	15	15	15	15	121	111	121	111
Sind	2	2	2	2	3	3	3	3	8	8	8	8
Bengal	6	6	4	3	5	5	5	5	35	35	30	30
United Provinces	8	8	6 (*a*)	6 (*a*)	11 (*b*)	10 (*b*)	9	8	52	52	52	52
Punjab	14	14	12	12	16	15	16	15	83	72	83	72
Burma	4	4	3	3	Class I 2 Class II 9	Class I 2 Class II 9	Class I 2 Class II 9	Class I 2 Class II 6	18	18	18	18
Bihar and Orissa	2	2	..	..	3	7	3	7	3	3	3	2
Central Provinces	2	2	2	2	Class I 3 Class II 6	Class I 3 Class II 5	Class I 1 Class II 5	Class I 1 Class II 5	22	20	22	20
Assam	2	2	2	2	..	..	..	..	11	11	11	11
North-West Frontier Province	1*	1*	1*	1*	1*	1*	1*	1*	4	4	4	4
TOTAL	52	52	42	41	93	94	88	87	469	443	450	24
(b) Indian States												
Hyderabad	2	2	2	2	2	3	1	2	9	9	9	9
Mysore	..	..	..	..	19	19	19	19	88	88	88	88
Baroda	..	1	..	1	..	2	..	1	..	3	..	3
Travancore	1	1	1	1	5	5	5	5	4	4	4	4

(*a*) Includes 5 I. A. S. posts, one U. P. A. S. post replacing 1 I. A. S. post held in abeyance. — (*b*) Including one temporary. | * Attend to both research and district work.

APPENDIX III—*contd.*

Staffs of Provincial and State Departments af Agriculture in India during 1931-32 and 1932-33—contd.

Province	DISTRICT STAFF											
	SUPERIOR SERVICE				PROVINCIAL SERVICE				SUBORDINATE SERVICE			
	Sanctioned cadre		Filled substantively		Sanctioned cadre		Filled substantively		Sanctioned cadre		Filled substantively	
	1931-32	1932-33	1931-32	1932-33	1931-32	1932-33	1931-32	1932-33	1931-32	1932-33	1931-32	1932-33
(a) British India												
Madras	8	8	7	7	17	15	17	15	254	246	222	212
Bombay—												
Presidency Proper	4	3	4	3	11	9	11	9	119	113	119	113
Sind	1	1	1	1	..	..	..	..	28	28	28	28
Bengal	4	4	2	2	8	8	7	6	263	263	199	199
United Provinces	12	12	8 (*c*)	7 (*c*)	17	16	17	16	161	161	161	161
Punjab	10	9	9	8	22	19	21	19	391	356	387	352
Burma	11	11	6	8	Class I 9 Class II 12	Class I 9 Class II 12	Class I 2 Class II 6	Class I 2 Class II 7	86	86	61	64
Bihar and Orissa	7	7	3	3	13	12	13	11	121 (*d*)	121 (*d*)	96	95
Central Provinces	11	11	5 (*e*)	6(*e*)	Class I 2 Class II 1	Class I 2 Class II 9	Class I 2 Class II 9	Class I 2 Class II 8	132	119	130	118
Assam	3	3	3	3	3	3	3	3	17	17	17	17
North-West Frontier Province	1*	1*	1*	1*	1*	1*	1*	1*	10	10	10	10
TOTAL	72	70	49	49	126	115	109	99	1,582	1,520	1,430	1,369
(b) Indian States												
Hyderabad	5	5	5	5	7	7	6	7	54	54	41	40
Mysore	..	..	..	..	17	17	17	17	347	354	347	354
Baroda	1	1	1	1	9	11	9	11	29	34	29	34
Travancore	1	1	1	1	12	12	12	12	16	16	16	16

(*c*) Includes 4 I. A. S. posts, 4 U. P. A. S. posts replacing I. A. S. posts held in abeyance.
(*d*) Includes 23 posts sanctioned but not filled in owing to funds not voted.
(*e*) Including Director of Agriculture.
* Attend to both research and district work.

APPENDIX IV

Results of well-boring in India during 1931-32 and 1932-33

Province	1930-31		1931-32		1932-33		Remarks
	Number of bores	Number successful	Number of bores	Number successful	Number of bores	Number successful	
(a) British India							
Madras	691	500	659	524	899	652	
Bombay	68	39	8	8	1	1	Boring operations have been closed as a measure of retrenchment.
Bengal	39	38	31	31	39	39	
United Provinces	1,402	1,070	1,499	1,070	1,714	1,217	
Punjab	887	686	620	439	441	409	
Bihar and Orissa	222	197	157	118	218	192	
TOTAL	3,309	2,530	2,974	2,190	3,312	2,510	
(b) Indian States							
Hyderabad	65	56	71	38	56	47	
Mysore	28	25	27	21	18	9	
Baroda	32	26	29	17	42	30	

APPENDIX V

Sale of improved implements through departmental agency in India during 1931-32 and 1932-33

Province	Ploughs			Cane Mills			Fodder cutters		
	1930-31	1931-32	1932-33	1930-31	1931-32	1932-33	1930-31	1931-32	1932-33
(a) British India									
Madras	753	789	1,172	11	24	49	36	4	8
Bombay—									
Presidency Proper	255	271	366	25	34	83	..	..	..
Sind	671	596	364	..	..	..	..	..	..
Bengal	43	29	45	2	1	11	2	1	1
United Provinces	4,954	1,937	2,550	217	676	554	137	155	685
Punjab	9,434	8,500	5,990	4,996	5,600	5,300	12,570	7,700	19,550
Burma	6,137	2,516	4,263	6	2	16	..	33	22
Bihar and Orissa	565	790	598	329	93	30	4	..	..
Central Provinces	2,700	2,328	1,835	112	212	240	38	18	15
Assam	..	2	..	97	48	85	..	..	..
North-West Frontier Province	1	..	..	..	..	..	..	..	..
Total	25,513	17,758	17,183	5,795	6,690	6,368	12,787	7,911	20,281
(b) Indian States									
Hyderabad	77	125	228	1	4	47	1	5	11
Mysore	1,550	1,138	1,317	47	72	54	..	..	1
Baroda	27	20	26	..	1	2	1	3	1
Travancore	12	159	2	..	..	..	..	..	..

APPENDIX V—*contd.*

Sale of improved implements through departmental agency in India during 1931-32 and 1932-33—contd.

Province	Hoes			Other Implements			Spare parts		
	1930-31	1931-32	1932-33	1930-31	1931-32	1932-33	1930-31	1931-32	1932-33
(a) British India									
Madras	3	67	45	330	728	1,015	1,239	832	1,743
Bombay—									
Presidency Proper	31	31	10	346	1,006	12,236	316	311	1,159
Sind	..	..	2	2	25	92	49	353	45
Bengal	8	4	..	1	24	49	6	14	16
United Provinces	76	32	86	3,329	4,542	1,023	5,742	6,093	9,229
Punjab	370	110	25	2,450	1,440	1,520	4,000	1,870	3,780
Burma	38	82	133	1,567	522	714	1,245	723	655
Bihar and Orissa	..	211	228	..	540	740	..	238	304
Cental Provinces	462	258	35	974	846	1,259	14,324	15,939	18,596
Assam	..	10	..	..	68	13	..	35	16
Total	988	805	564	8,999	9,741	18,661	26,921	26,408	35,543
(b) Indian States									
Hyderabad	15	45	22	23	26	98	4	..	54
Mysore	..	..	..	..	..	..	..	..	..
Travancore	..	..	..	..	..	102	..	..	2
Baroda	1	..	..	..	2	15	..	..	..

APPEN

Improved seeds and manures distributed through

Province	SEEDS DIS					
	SEED GRAIN CWT			NO. OF WHOLE CANES EXCEPT WHERE OTHERWISE STATED		
	1930-31	1931-32	1932-33	1930-31	1931-32	1932-33
(a) British						
Madras	10,434	*12,869	(a)16,890	2,314,223	64,536	355,803
Bombay—						
Presidency Proper	25,371	24,083	13,476	203,940	272,210	10,201,670
Sind	4,918	2,411	2,749	..	9 cwts. 54 lbs.	498
Bengal	8,885	5,662	3,842	1,405,305	3,779,140	4,290,605
United Provinces	132,822	123,756	185,487	646,472 cwts.	573,856 cwts.	1,311,170
Punjab	49,140	35,530	38,768	(b)	(b)	(b)
Burma	87,237	104,323	111,998	200,780	241,700	477,000
Bihar and Orissa	3,087	4,496	4,945	357,215 + 468 cwts.	369,288 + 787 cwts.	310,910 + 110 cwts.
Central Provinces	362,542	243,530	242,199	1,081,312	1,179,863	1,987,519
Assam	1,759	2,016	3,049	278,329	110,073	124,874
North-West Frontier Province (b)	..	..	..	..	..	..
TOTAL	686,195	558,676	623,403	..	..	..
(b) Indian						
Hyderabad	20,378	30,644	29,301	564 cwts.	952 cwts.	1,269 cwts.
Mysore	3,492	2,024	2,711	2,662,894	229,647	2,612,984
Baroda	704	71	135	..	14,507	7,075
Travancore	208	431	236	1,000	1,000	5,855

* Includes 483 cwt. of
(a) Includes 590 cwt.
(b) Information not

DIX VI

departmental agency in India during 1931-32 and 1932-33

TRIBUTED			MANURES DISTRIBUTED					
FRUIT PLANTS No.			COMMERCIAL FERTILIZERS IN CWT.			OIL-CAKES IN CWT		
1930-31	1931-32	1932-33	1930-31	1931-32	1932-33	1930-31	1931-32	1932-33
India								
39,031	52,305	129,480	..	651	1,316	..	1,360	1,329
31,634	46,961	73,475	9,170	5,834	12,082	376	1,236	2,393
591	3,485	7,943	3	3	..	..	..	..
100	..	12	350	100	281	133	234	248
15,599	16,025	10,920	9,528	11,908	14,018	22,729	13,585	20,449
(*b*)	(*b*)	(*b*)	(*b*)	(*b*)	(*b*)	(*b*)	(*b*)	(*b*)
3,076	2,874	7,625	1,315	114	3,150	..	..	..
554	1,941	3,313	20,322	130,091	18,491	..	..	..
..	..	..	..	..	..	..	..	..
1,992	1,111	3,545	1,375	1,788	828	97	107	119
..	..	..	..	..	..	..	..	..
93,477	124,702	236,113	42,063	150,489	50,166	23,335	16,522	24,538
States								
..	..	..	42	214	570	353	496	510
7,940	20,244	17,818	3,809	3,357	20,140	237	40	28
2,039	3,203	9,338	160	328	585	..	..	2
..	225	632	..	..	..	..	..	..

seed potatoes.
of seed potatoes.
available.

APPENDIX VII

Demonstration and propaganda work in India during 1931-32 and 1932-33

Province	Number of Agricultural Shows held			Number of Practical Demonstrations carried out			Number of Illustrated Lectures given		
	1930-31	1931-32	1932-33	1930-31	1931-32	1932-33	1930-31	1931-32	1932-33
(a) British India									
Madras	153	176	199	7,048	12,737	14,915	459	405	495
Bombay—									
Presidency Proper	29	166	98	1,610	1,660	1,637	186	302	500
Sind	6	13	6	429	369	271	..	8	10
Bengal	38	27	31	2,861	2,167	2,709	177	133	191
United Provinces	112	98	131	18,846	17,060	23,966	335	851	141
Punjab	..	..	..	..	..	..	..	..	..
Burma	22	12	12	1,182	1,730	1,590	174	64	131

Bihar and Orissa	15	18	20	8,235	8,645	8,441	9	13	21
Central Provinces	23	17	28	4,200	4,485	4,709	343	392	701
Assam	5	1	1	1,953	2,885	3,169	73	43	23
North-West Frontier Province	..	..	..	..	..	..	..	..	..
TOTAL	403	528	526	45,622	51,738	61,407	1,756	2,211	2,213

(b) Indian States

Hyderabad	4	21	35	415	698	924	23	21	34
Mysore	40	94	11	1,688	1,181	1,167	77	44	74
Baroda	4	6	13	1	8	5	..	8	6
Travancore	5	5	3	..	123	140	20	25	27
Patiala	17	..	..	706	..	..	..	..	..

APPEN

Agricultural Colleges and Schools

Name of College or School	Courses of instruction	1930-31			
		Applications for admission	Admissions made during the year	Total number on the roll	Number passed in the final examination
					(a) BRITISH
					(i) Post-graduate
Imperial Institute of Agricultural Research, Pusa.	(1) Two-year Post-graduate course.	30	5 (*a*)	16	6
	(2) One-year Post-graduate course in farm management and organisation and general farm-engineering.	..	2	3	1
	(3) Special courses . . .	..	..	1	1
Imperial Institute of Animal Husbandry and Dairying, Bangalore.	(1) Fifteen-month Post-graduate course.	5	3 (*a*)	8	5
	(2) Two-year Indian Dairy Diploma course.	..	..	24	..
	(3) Special short course . .	10	10	10	10
Imperial Cane Breeding Station, Coimbatore.	Special short course . .	..	1	1	..
					(ii) Provincial Agri
Agricultural College, Coimbatore.	Three-year B.Sc. Ag. Degree course.	..	..	..	..
Agricultural College, Poona.	(1) Three-year B.Ag. Diploma course.	139	80	210	54
	(2) College Diploma course .	..	..	..	3
Agricultural College, Cawnpore.	(1) B.Sc. (Agrl.) . . .	255	42	152	32
	(2) Vernacular . . .	81	21	32	13
Punjab Agricultural College, Lyallpur.	(1) Four-year B.Sc.Ag. Degree course.	110	40	264	57
	(2) One-and-a-half-year M.Sc. Degree course.	1	1	4	3
	(3) Two-year certificate course	..	..	..	..
	(4) Six-month Vernacular course (summer class).	(*g*)	32	27	21
	(5) Six-month Vernacular course (winter class).	(*g*)	34	34	28
	(6) One-month Rural Economy course.	23	23	23	23
	(7) Ten-and-a-half-month Teachers' Training course.	44	28	25	23
	(8) Six-week Blacksmith course	27	13	13	13
	(9) Six-month Vernacular course in Dairying.	..	..	..	..

(*a*) One left without
(*b*) Two left without
(*c*) One student who left
(*d*) Four left without
(*e*) Includes one repeat
(*f*) The total number of
(*g*) Applications for ad-
(*h*) One compartment of

DIX VIII

in India during 1931-32 and 1932-33

1931-32				1932-33			
Applications for admission	Admissions made during the year	Total number on the roll	Number passed in the final examination	Applications for admission	Admissions made during the year	Total number on the roll	Number passed in the final examination
INDIA							
Training Institution							
40	2 (*a*)	11	5	33	13 (*b*)	18	4
..	2 (*a*)	4	2	..	3	4	1
..	..	1	..	..	7	8	8
..	..	2	2	4	2 (*c*)	2	1
67	22 (*d*)	43 (*e*)	20	..	..	19	..
30	30 (*a*)	29	2	18	18	45	27
..	1	2 (*a*)	1	..	..	..	..
cultural Colleges							
321	48	59	54	180	48	51	48
100	50	172	64	83	45	145	77
..	..	..	..	..	..	..	..
120	50	160	37	127	62	40	30
..	..	..	10	..	..	..	..
75 (*f*)	56	218	53	76 (*f*)	59	171	47
..	..	2	1	2	2	3	1
..	..	8	6	..	..	8	8
(*g*)	32	27	23	(*g*)	14	13	11
(*g*)	23	19	17	(*g*)	12	5	5
11	11	11	11	9	9	9	9
28	23	22	23 (*h*)	17	12	12	12
23	13	12	12	69	20	19	19
78	7	7	6	54	10	10	6

completing the course.
completing the course.
without completing the course in 1931 was readmitted to complete it.
completing the course.
course.
applications received for admission to L. C. class and degree course.
mission were received by respective Deputy Director of Agriculture, and the selection was made by them.
the last year.

Agricultural Colleges and Schools

Name of College or School	Courses of instruction	1930-31			
		Applications for admission	Admissions made during the year	Total number on the roll	Number passed in the final examination
(ii) Provincial Agri					
Agricultural College, Mandalay.	Three-year Diploma course .	78	23	42	8
Agricultural College, Nagpur.	Four-year Degree course . .	132	34	126	9
(iii) Agricul					
Madras					
Agricultural Middle School, Taliparamba.*	Two-year course of theoretical and practical agricultur and nature study combined with non-technical subjects of arithmetic, Malyalam history and geography.	..	..	..	..
School for Juvenile and adult labourers, Coimbatore.	Three R's I and II Standard in Tamil.	..	..	..	..
Ditto, Palur near Nellikuppam.	Ditto, in Vernaculars I-V in Tamil.	..	..	..	..
Ditto, Anakapalle .	Ditto in Telugu . . .	..	..	..	..
Bombay					
Vernacular Agricultural School, Dhulia.	Two-year course . . .	18	17	32	15
Vernacular Agricultural School, Devihosur.	Two-year course . . .	128	24	37	13
Bengal					
Secondary Agricultural School, Dacca.	Two-year course . . .	58	27	52	28
United Provinces					
Vernacular Agricultural School, Bulandshahr.	(1) Two-year course . .	91	37	64	61
	(2) Fieldman class . . .	8	8	8	5
	(3) Farm Mechanics class .	25	10	10	9
	(4) Teachers' Training class .	33	33	33	43
	(5) Garden Overseers course .	10	1	1	1
Agricultural School, Gorakhpur.	(1) Two-year course (session commenced July 1931).	..	..	..	..
	(2) Fieldman course† . .	12	7	7	6
Punjab					
Agricultural Vernacular class, Gurdaspur.	(1) Six-month Vernacular course (summer class).	37	25	22	22
	(2) Six-month Vernacular course (winter class).	23	12	10	10

(i) There were no stu
* The school was closed
†Admission made in

in India during 1931-32 and 1932-33—contd.

1931-32				1932-33			
Applications for admission	Admissions made during the year	Total number on the roll	Number passed in the final examination	Applications for admission	Admissions made during the year	Total number on the roll	Number passed in the final examination
cultural Colleges—*contd.*							
..	..	26	8	..	..	18	16
84	54	106	(i)	75	32	111	24
tural Schools							
4	3	3	3	..	..	..	..
..	11	15	11	..	40	10	..
19	19	26	2	18	18	25	3
34	28	40	31	15	8	32	25
49	16	33	17	42	15	31	15
92	14	36	16	81	16	28	14
120	16	38	25	120	16	28	22
61	61	70	61	61	30	59	28
5	5	4	4	6	6	6	6
25	10	10	9	16	8	8	7
..	..	32	32	..	..	..	..
..	..	..	..	..	..	..	..
81	37	30	29	47	32	29	29
17	13	13	12	19	5	5	5
25	14	13	13	28	11	11	11
20	11	11	11	32	18	18	17

dents in the final year.
from 1st April 1932.
January each year.

Agricultural Colleges and Schools

Name of College or School	Courses of instruction	1930-31			
		Applications for admission	Admissions made during the year	Total number on the roll	Number passed in the final examination
(iii) Agricul					
Agricultural Vernacular class, Hansi.	(1) Six-month Vernacular class (summer class).	49	13	8	8
	(2) Six-month Vernacular class (winter class).	47	14	10	9
Burma					
Agricultural School, Pyinmana.	Four-year course and 2-year course.	..	43	79	12 (4 years) 20 (2 years)
Central Farm School, Hmwabi.	Nine-month course . .	..	..	9	8
Central Farm School, Mahlaing.	Nine-month course . .	33	12	11	11
Training for adult cultivators.	Short course	14	122	30	52
Central Farm School, Mudon.	Short courses of practical instructions.	..	14	..	7
Central Farm School, Tatkon.	Ditto .	..	4	4	4
Central Farm School, Padu.	Ditto .	..	14	14	14
Central Farm School, Allanmyo.	(1) Ditto .	..	53	..	..
	(2) For one year . . .	..	10	..	..
Central Provinces.					
Anglo-Vernacular Middle School, Powerkhera.	Four-year course . . .	48	31	89	13
North-West Frontier Province					
F. E. A. class Islamia College, Peshawar.	Four-year course . . .	..	..	..	..
(b) INDIAN					
Mysore					
1. Hebbal Agricultural School.	Three-year course leading to Diploma in Agriculture.	221	80	116	51
2. Rama Krishna Krishisala.	One-year course in vernacular				
3. S. K. V. D. Patsala Chikkanhalli.					
4. The Hassan Agricultural School.					
Travancore					
Agricultural School, Alwaye.	Two-year course . . .	50	21	16	(i)
Agricultural School, Kottra-kara.	Ditto . . .	150	32	29	..
Agricultural School, Koni.	Ditto . . .	200	52	52	..

(i) Final examination

in India during 1931-32 and 1932-33—concld.

1931-32				1932-33			
Applications for admission	Admissions made during the year	Total number on the roll	Number passed in the final examination	Applications for admission	Admissions made during the year	Total number on the roll	Number passed in the final examination
tural Schools—*contd.*							
..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..
..	50	76	22	..	39	55	21
..	..	9	9	27	10	9	9
42	12	11	11	73	12	11	11
13	117	17	17	148	21	21	21
..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..
34	24	81	17	33	29	84	23
..	..	..	..	..	20	20	..
STATES							
297	77	122	57	293	84	125	58
		Temporarily closed for 2 years from August 1932.					
..	..	29	26	76	24	19	No examination.
..	..	..	48	..	..	52	48

in 1932 only.

APPENDIX IX

Operations of Non-credit Agricultural Co-operative Societies in India during 1931-33

The two tables below include Agricultural Societies for—

A. 1. *Purchase and Purchase and Sale.* These are societies intended to facilitate the purchase of agricultural requisites for members, such as societies which purchase seed, manure, implements, etc., for sale to their members. Societies of this character which collect for joint sale the produce of members without making this their main object are also included in this class.

2. *Production.* These are societies which have for their chief object an act of production without proposing to themselves sale as a direct object. These also include societies for joint irrigation, for collective use of machinery, for assistance in horse and cattle-breeding, etc.

3. *Production and sale.* This class includes societies in which these two functions are united or in which one or the other predominates, it being impossible to make a clear distinction between them. It covers all societies whose main object is the joint sale of any commodity, whether such commodity is produced or worked up or prepared for sale by the society itself or by the members individually. It comprises all co-operative creameries and distilleries, as well as societies whose main object is the sale of grain, cattle, eggs, *ghi*, etc., produced by their members.

4. Other forms of co-operation except insurance.

B. Insurance.

APPENDIX IX—*contd.*

Operations of Non-credit Agricultural Co-operative Societies in India during 1931-32 and 1932-33

(A) Purchase, Sale and Production

Province	Class of Societies	1931-32						1932-33					
		Number of Societies	Number of Members	Sale of goods to Members	Purchase of Members' Products	Working Capital	Profit and loss for the year	Number of Societies	Number of Members	Sale of goods to Members	Purchase of Members' Products	Working Capital	Profit and loss for the year
				Rs.	Rs.	Rs.	Rs.			Rs.	Rs.	Rs.	Rs.
Madras	Purchase and purchase and sale.	89	12,305	1,71,784	10,67,547	4,18,220	—15,101	78	12,137	2,55,158	1,96,735	4,60,723	2,174
	Production and sale	21	1,163	..	..	1,03,342	—3,516	11	922	9,473	3,503	1,12,849	—3,039
	Others . . .	370	23,314	363	5	4,21,019	—9,326	348	22,372	15,337	1,582	3,94,059	—6,850
	Total .	480	36,782	1,72,147	10,67,552	9,42,581	—27,943	437	35,431	2,79,968	2,01,820	9,67,631	—7,715
Bombay	Purchase and purchase and sale.	41	3,736	17,450	8,497	3,58,732	5,536	41	4,754	10,751	17,557	4,28,934	10,905
	Production . .	17	650	..	..	8,689	40	17	667	..	..	9,381	198
	Production and sale	72	14,616	4,93,179	4,86,898	12,90,370	45,128	74	14,925	1,76,401	1,08,756	12,81,936	52,124
	Others . . .	106	45,857	41,728	5,03,974	3,98,543	421	113	47,765	47,484	5,953	4,34,954	29,473
	Total .	236	64,859	5,52,357	9,99,369	20,56,334	51,125	245	68,111	2,34,636	1,32,266	21,55,205	92,700
Bengal	Purchase and purchase and sale.	89	12,394	4,75,144	3,96,729	6,81,627	2,501	85	11,468	3,92,814	3,19,913	6,61,249	—4,542
	Production . .	933	24,075	22	..	4,63,344	—9,274	932	22,832	..	..	4,69,251	—11,368
	Production and sale	270	13,929	3,43,310	5,77,302	9,58,289	68,445	272	14,384	2,85,152	5,19,926	9,61,766	93,128
	Others . . .	42	9,444	1,170	572	1,26,147	—3,578	44	9,506	750	493	2,10,436	814
	Total .	1,334	59,842	8,19,646	9,74,603	22,29,407	58,094	1,333	58,190	6,78,716	8,40,332	23,02,702	78,032

APPENDIX IX—*contd.*

Operations of Non-credit Agricultural Co-operative Societies in India during 1931-32 and 1932-33—contd.

(A) PURCHASE, SALE AND PRODUCTION—*contd.*

Province	Class of Societies	1931-32						1932-33					
		Number of Societies	Number of Members	Sale of goods to Members	Purchase of Members' Products	Working Capital	Profit and loss for the year	Number of Societies	Number of Members	Sale of goods to Members	Purchase of Members' Products	Working Capital	Profit and loss for the year
				Rs.	Rs.	Rs.	Rs.			Rs.	Rs.	Rs.	Rs.
United Provinces	Production and sale	42	1,201	55,505	58,657	18,829	7,752	56	2,392	96,321	1,18,755	51,879	2,472
	Others . . .	330	7,701	168	1,377	10,331	631	373	9,357	553	2,609	18,900	367
	TOTAL .	372	8,902	55,673	60,034	29,160	8,383	429	11,749	96,874	1,21,364	70,779	2,839
Punjab	Purchase and purchase and sale.	19	1,483	97,755	93,142	69,746	2,097	19	1,661	1,33,503	1,30,207	74,628	4,264
	Production . .	158	4,020	50	..	6,584	477	154	3,994	415	433	6,542	221
	Production and sale	1,069	67,542	17,92,898	19,89,795	6,60,746	13,471	1,182	76,617	15,37,374	18,38,921	6,55,649	13,575
	Others . . .	85	1,651	..	..	77,638	7,836	91	1,755	..	..	86,180	6,655
	TOTAL .	1,331	74,696	18,90,703	20,82,937	8,14,714	23,881	1,446	84,027	16,71,292	19,69,561	8,22,999	24,715
Burma	Purchase and purchase and sale.	12	813	4,078	..	36,989	123	11	688	..	..	31,144	—95
	Production . .	5	50	..	..	..	..	5	50	..	..	..	..
	Production and sale	14	1,383	1,757	..	1,34,211	—31,811	14	1,392	1,846	..	1,33,000	—34,784
	TOTAL .	31	2,246	5,835	..	1,71,200	—31,688	30	2,130	1,846	..	1,64,144	—34,879

Bihar and Orissa	Purchase and purchase and sale.	3	271	313	..	2,673	—465	2	247	..	..	1,255	—34
	Production . .	3	161	..	..	8,009	—430	2	121	..	..	7,082	—394
	Production and sale	2	59	..	976	11,946	—779	2	64	..	1,576	11,780	—558
	Others . . .	5	248	..	..	1,378	91	5	265	..	..	1,603	430
	Grain golas . .	68	20,552	..	..	3,74,960	30,697	70	21,753	65	91	3,50,947	28,607
	TOTAL .	81	21,291	313	976	3,98,966	29,114	81	22,450	65	1,667	3,72,667	28,051
Central Provinces	Purchase and purchase and sale.	31	1,487	55,569	12,445	2,66,385	6,774	36	1,670	46,239	26,927	2,98,232	+11,036
	Production . .	2	44	..	..	456	..	11	235	..	..	1,181	+171
	Production and sale	9	744	3,258	..	32,319	26	10	747	1,866	..	28,833	+1,139
	TOTAL .	42	2,275	58,827	12,445	2,99,160	6,800	57	2,652	48,105	26,927	3,28,246	+12,346
Assam	Purchase and purchase and sale.	27	1,921	1,85,376	10,119	96,160	2,416	29	930	1,43,664	9,045	75,488	2,123
	Grain golas . .	3	58	..	..	Md. Sr. 1,270 17	Md. Sr. 231 10	3	63	..	Md. Sr. 1,502 27	Md. Sr. 331 32	..
	TOTAL .	30	1,979	1,85,376	10,119	Rs. 96,160 and Md. Sr. 1,270 17	Rs. 2,416 and Md. Sr. 231 10	32	993	1,43,664	Rs. 9,045 and Md. Sr. 1,502 27	Rs. 75,488 and Md. Sr. 331 32	2,123
Delhi	Cattle breeding .	1	68	..	..	..	..	1	68	..	..	..	..
	Consolidation of holdings.	6	424	..	..	..	..	8	533	..	..	..	..
	TOTAL .	7	492	..	..	..	..	9	601	..	..	..	..

APPENDIX IX—*contd.*

Operations of Non-credit Agricultural Co-operative Societies in India during 1931-32 and 1932-33—contd.

(A) PURCHASE, SALE AND PRODUCTION—*concld.*

Province	Class of Societies	1931-32						1932-33					
		Number of Societies	Number of Members	Sale of goods to Members	Purchase of Members' Products	Working Capital	Profit and loss for the year	Number of Societies	Number of Members	Sale of goods to Members	Purchase of Members' Products	Working capital	Profit and loss for the year
				Rs.	Rs.	Rs.	Rs.			Rs.	Rs.	Rs.	Rs.
Baroda State	Purchase and sale	15	526	4,966	..	4,725	—253	20	589	1,808	..	3,666	—125
	Production	18	577	1,035	..	33,246	—2	25	691	3,475	..	38,086	87
	Production and sale	36	1,408	6,554	7,19,630	17,783	1,331	37	1,211	101	12,47,749	26,344	4,118
	TOTAL	69	2,511	12,555	7,19,630	55,754	1,076	82	2,491	5,384	12,47,749	68,096	4,080
Mysore	Purchase and purchase and sale.	48	1,147	12,104	..	76,043	127	45	1,083	9,809	65	76,059	991
	Production	1	13	..	..	3,612	..	1	13	..	..	3,612	..
	Production and sale	17	408	2,438	1,947	13,565	911	18	444	3,039	2,503	13,702	1,549
	Grain golas	55	2,149	..	..	10,225	247	54	1,883	..	..	9,403	143
	TOTAL	121	3,717	14,542	1,947	1,03,445	1,285	118	3,423	12,848	2,568	1,02,776	2,683
N.-W. F. Province	Consolidation of holdings.	6	1,378	..	..	..	..	8	2,031	..	..	..	..
	TOTAL	6	1,378	..	..	..	..	8	2,031	..	..	..	..

(B) CATTLE INSURANCE

Province	Number of societies	Amount of risk insured	Premia collected during the year	Supplementary contributions collected	Number of animals		Claims paid	Cost of management	Funds in hand at the end of the year	Amount of risk re-insured	Amount of premia paid for re-insurance
					Insured	Lost					
		Rs.	Rs.	Rs.			Rs.	Rs.	Rs.	Rs.	Rs.
1931-32											
Madras . . .	3	..	..	..	..	..	..	..	50	..	..
Bombay . . .	2	27,060	643	..	430	11	446	543	1,647	..	..
1932-33											
Madras . . .	*Nil*	..	..	..	..	..	..	..	..	..	..
Bombay . . .	2	18,830	925	..	301	16	606	419	1,691	..	..

APPENDIX X

Showing the working of the Veterinary Departments in India during 1931-32 and 1932-33.

Province	1931-32											
	Reported mortality from contagious diseases			Dispensaries and hospitals			District work					
	Rinderpest	Other diseases	Total	Number of institutions	Cases treated	Castrations performed	Cases treated	Castrations performed	Outbreaks in which inoculation was undertaken	Deaths uninoculated	Inoculations	Deaths after inoculation
(a) British India												
Madras	28,412	28,307	56,719	118	204,185	10,783	74,147	20,916	1,197	18,947	158,723	432
Bombay	14,081	7,333	21,414	107	240,759	25,309	70,533	13,205	1,067	11,576	116,984	229
Bengal	10,373	4,924	15,297	48	95,713	141	126,907	350	642	2,125	134,493	850
United Provinces	47,761	9,596	57,357	169	347,797	25,739	53,881	9,549	2,095	25,903	216,997	403
Punjab	9,335	294	9,629	288	1,144,647	231,945	372,061	204,616	1,917	7,018	375,431	458
Burma	8,689	3,132	11,821	4	7,360	44	96,883	36	647	6,197	115,814	923
Bihar and Orissa	16,053	5,631	21,684	126	75,153	13,499	135,675	69,252	767	5,907	134,269	365
Central Provinces	9,332	10,363	19,695	102	166,517	11,300	362,154	96,666	1,063	7,769	279,379	35
Assam	11,007	10,716	21,723	3	4,794	312	85,340	17,062	261	5,668	14,994	402
North-West Frontier Province	180	1,350	1,530	27	89,553	16,603	75,689	30,902	79	769	20,048	2
Sind	27,130	2,217	29,347	18	29,044	1,928	6,574	388	228	3,968	17,258	238
Baluchistan	88	4,109	4,197	10	71,280	354	71,280	354	..	337	809	61
TOTAL	1,82,441	87,972	270,418	1,020	2,476,802	337,957	1,531,214	463,296	9,963	96,184	1,585,199	4,398
TOTAL FOR 1930-31	2,03,758	1,13,152	316,910	1,012	2,485,389	284,968	1,355,877	415,126	9,403	115,057	1,548,982	3,568
(b) Indian States												
Mysore	1,201	14,422	15,623	60	3,62,611	19,448	81,352	33,065	200	1,201	127,089	62
Hyderabad	20,355	1,878	22,233	70	212,415	..	59,817	18,611	476	12,820	144,722	810
Coorg	533	388	921	4	21,283	90	2,430	458	93	310	3,758	24

Showing the working of the Veterinary Departments in India during 1931-32 and 1932-33—contd.

Province	1932-33											
	Reported mortality from contagious diseases			Dispensaries and hospitals			District work					
	Rinderpest	Other diseases	Total	Number of institutions	Cases treated	Castrations performed	Cases treated	Castrations performed	Outbreaks in which inoculation was undertaken	Deaths uninoculated	Inoculations	Deaths after inoculation
(a) British India												
Madras	12,735	27,514	40,249	113	225,897	13,398	74,132	28,083	997	12,789	188,839	314
Bombay	29,170	8,918	38,088	109	226,878	22,161	66,882	5,541	1,345	20,823	163,757	239
Bengal	16,694	8,190	24,884	48	100,982	267	173,550	1,678	773	15,952	192,243	966
United Provinces	43,600	11,510	55,110	171	383,979	39,397	93,183	15,888	2,048	28,306	224,181	439
Punjab	17,584	101	17,685	293	1,208,500	250,142	440,299	226,445	785	7,049	139,077	286
Burma	19,199	3,273	22,472	3	4,259	19	61,978	26	1,291	8,776	201,418	1,036
Bihar and Orissa	15,215	5,523	20,738	126	83,273	16,558	101,762	77,868	881	6,676	164,304	296
Central Provinces	31,807	7,367	39,174	103	173,644	13,391	474,906	105,769	2,500	14,090	399,991	117
Assam	12,288	12,012	24,300	3	5,201	285	92,234	20,987	370	8,370	20,150	287
North-West Frontier Province	573	1,585	2,158	41	127,738	23,174	102,279	29,155	91	685	23,624	10
Sind	10,372	2,108	12,480	18	28,912	1,818	3,963	474	138	2,235	11,775	84
Baluchistan	287	2,692	2,979	10	65,143	270	65,143	270	..	364	4,870	12
TOTAL	209,524	90,793	300,317	1,038	2,634,406	380,880	17,50,311	512,184	11,219	126,115	1,734,229	4,086
(b) Indian States												
Mysore	1,065	14,988	16,053	60	416,990	18,910	66,583	52,651	81	909	135,090	83
Hyderabad	14,506	8,694	23,200	75	247,904	..	93,046	27,910	624	15,727	178,544	654
Coorg	612	509	1,121	4	33,094	93	4,537	283	177	576	3,834	51

APPENDIX XI

Showing the working of the Veterinary Colleges and Schools in India during 1931-32 and 1932-33

Veterinary College or School	Length of Course	NUMBER OF STUDENTS						EDUCATIONAL QUALIFICATIONS OF STUDENTS ADMITTED		
		ADMITTED DURING THE YEAR		Passed final examination	Failed in final examination	UNDER INSTRUCTIONS AT END OF YEAR		Intermediate and above	Matriculate or S. L. C.	Lower qualifications
		Scholarship holders	Others			Ordinary course	Failed students			
				1931-32						
Madras Veterinary College	3 years	12	34	39	9	125	46	13	33	..
Bombay Veterinary College	3 years	3	24	21	7	93	23	..	27	..
Bengal Veterinary College	3 years	30	58	34	18	90	44	132		37
Punjab Veterinary College	4years	2	18	32	8	134	8	20	..	..
Insein Veterinary School	2 years, Vernacular course.	34	Students were given refresher course.							
Bihar and Orissa Veterinary College	3 years	12	9	8	3	29	15	..	21	..
				1932-33						
Madras Veterinary College	3 years	4	41	22	9	118	45	14	31	..
Bombay Veterinary College	3 years	3	26	27	12	70	29	..	29	..
Bengal Veterinary College	3 years	25	35	22	17	103	50	153		23
Punjab Veterinary College	4 years	2	8	49	4	93	4	10	..	..
Insein Veterinary School	2 years, vernacular course.	*Nil*	*Nil*	*Nil*	*Nil*	*Nil*	*Nil*	*Nil*	*Nil*	*Nil*
Bihar and Orissa Veterinary College.	3 years	7	3	15	3	19	10	..	10	..

APPENDIX XII

Showing the number of cattle issued from Government Farms during 1931-32 and 1932-33

Province	1931-32						1932-33					
	Bulls	Cows	Male buffaloes	She buffaloes	Young stock	Total for 1931-32	Bulls	Cows	Male buffaloes	She buffaloes	Young stock	Total for 1932-33
Madras	71	101	13	21	58	264	64	164	6	30	47	311
Bombay (excluding Sind)	..	..	..	..	..	149	105	43	..	5	23	176
Bengal	12	..	..	..	..	12	14	..	2	..	..	16
United Provinces	427	..	128	..	..	555	406	..	..	53	..	459
Punjab	376	..	..	..	..	376	490	..	..	..	..	490
Burma	14	15	..	..	29	58	5	5	..	..	11	21
Bihar and Orissa	14	42	7	..	222	285	*32 44	31	5	..	55	167
Central Provinces	54	69	3	4	51	181	38	36	16	2	16	108
Assam	16	11	..	..	13	40	29	34	..	..	24	87
North-West Frontier Province	*Nil*	*Nil*	*Nil*	*Nil*	*Nil*	*Nil*	*Nil*	*Nil*	*Nil*	*Nil*	*Nil*	*Nil*
Sind	6	..	..	..	..	6	2	13	..	10	10	35
TOTAL	990	238	151	25	373	1,926	1,229	326	29	100	186	1,870
Imperial and other Farms												
Pusa	..	17	..	..	56	73	5	34	..	..	17	56
Karnal	3	112	..	26	250	391	1	12	..	3	119	135
Bangalore	3	84	1	3	105	196	2	35	3	..	124	164
Wellington	1	54	..	..	34	89	..	..	..	..	..	..
Mysore State	63	..	..	..	45	108	61	1	..	..	2	64
Hyderabad State	1	3	..	..	..	4	1	3	..	..	..	4
Travancore	..	4	..	..	9	13	3	9	..	..	23	35

* Draft bullocks.

APPENDIX XIII

List of Agricultural Publications in India during 1931-33

No.	Title	Author	Where published
	GENERAL AGRICULTURE		
1	*Agriculture and Livestock in India* (Bi-monthly), Vol. I, parts 4, 5 and 6; Vol. II, parts 1, 2, 3, 4, 5 and 6; Vol. III, parts 1, 2 and 3. Annual subscription Rs. 6-0-0 or 9*s.* 9*d.* (inclusive of Indian postage), price per part Rs. 2-0-0 or 3*s.* 6*d.* (inclusive of Indian postage).	Issued under the authority of the Imperial Council of Agricultural Research.	Manager of Publications, Civil Lines, Delhi.
2	*The Madras Agricultural Journal* (Monthly). Annual subscription Rs. 4.	T. V. Ramakrishna Ayyar (Editor). Published by the M. A. S. Union, Agricultural and Research Institute, Coimbatore.	The Scholar Press, Palghat.
3	*The Journal of the Trichinopoly District Agricultural Association* (English and Tamil) (Quarterly). Annual subscription Re. 1-8 for non-members, free for members.	Issued by the Trichinopoly District Agricultural Association, Teppakulam post.	Muruga Vilas, Jananu Koola Press, Trichinopoly.
4	*The Gardening Review* (Monthly). Annual subscription Rs. 3 or 6*s.*	C. V. Krishnaswami Ayyar (Editor).	The Peerless Press, Madras.
5	*Poona Agricultural College Magazine* (Quarterly). Annual subscription Rs. 2-8.	V. G. Deshpande and S. M. Rao (Editors).	Arya Bhushan Press, Poona City.
6	*Shetki Shetkhari* (Monthly). Annual subscription Re. 1-3.	Narhar Gangadhar Apte.	Ditto.
7	*Krishi Sampad* (Monthly). Annual subscription Rs. 3.	N. K. Ghosh . .	Krishi Sampada Press, Dacca.
8	*Mufidul Mazarain* (Urdu) .	Issued by the Department of Agriculture, United Provinces.	Government Printing and Stationery, United Provinces, Allahabad.
9	*Kisan Upkarak* (Hindi) . .	Ditto .	Ditto.
10	*Kisan* (Hindi) (Quarterly). Annual subscription Rs. 2. Published by the Bihar and Orissa Agricultural Association.	Rajandhari Singh and B. N. Sarkar.	The United Press, Ltd., Patna.
11	*The Allahabad Farmer* (Bi-monthly). Annual subscription Rs. 3 or 4*s.*	W. J. Hansen (Managing Editor). Published by the Agricultural Institute, Allahabad.	The Mission Press, Allahabad.

List of Agriculutral Publications in India during 1931-33—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE—*contd.*		
12	*Seasonal Notes* (Half yearly). Price, As. 4 per copy.	Issued by the Department of Agriculture, Punjab.	Government Printing, Punjab, Lahore.
13	*The Nagpur Agricultural College Magazine* (Quarterly). Annual subscription Rs. 3-4.	Published by P. D. Nair, Agricultural College, Nagpur.	The Central India Printing Works, Nagpur.
14	Review of Agricultural Operations in India, 1929-30 and 1930-31. Price, Rs. 5 or 8*s.* 3*d.*	Issued under the authority of the Imperial Council of Agricultural Research.	Manager of Publications, Civil Lines, Delhi.
15	Annual Report of the Imperial Council of Agricultural Research for the years 1929-30 and 1930-31. Price, As. 12 or 1*s.* 3*d.*	Ditto .	Ditto.
16	Annual Report of the Imperial Council of Agricultural Research for the year 1931-32. Price, As. 6 or 8*d.*	Ditto .	Ditto.
17	Annual Report of the Imperial Council of Agricultural Research for the year 1932-33. Price, As. 6 or 8*d.*	Ditto .	Ditto.
18	Annual Report of the Indian Central Cotton Committee, Bombay for the year ending 31st August 1931 (including the Annual Report of the Director, Technological Laboratory). Price, Rs. 2.	Secretary, Indian Central Cotton Committee, Bombay and Director, Technological Laboratory.	Secretary, Indian Central Cotton Committee, Bombay.
19	Annual Report of the Indian Central Cotton Committee, Bombay for the year ending 31st August 1932 (including the Annual Report of the Director, Technological Laboratory). Price, Rs. 2.	Secretary Indian Central Cotton Committee, Bombay.	Ditto.
20	Cotton Improvement in India. Bulletin of the Indian Central Cotton Committee.	Ditto .	Ditto.
21	Report on the Operations of the Department of Agriculture, Madras Presidency for 1930-31. Price, Re. 1-2.	Issued by the Department of Agriculture, Madras.	Government Press, Madras.
22	Report on the Operations of the Department of Agriculture, Madras Presidency for 1931-32.	Ditto .	Ditto.

List of Agricultural Publications in India during 1931-33—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE—*contd.*		
23	Reports of subordinate officers of the Department of Agriculture, Madras for 1930-31. Price, Rs. 6.	Issued by the Department of Agriculture, Madras.	Government Press, Madras.
24	Reports of subordinate officers of the Department of Agricul ture, Madras for 1931-32.	Ditto .	Ditto.
25	Villagers' Calendar for 1931-32 and 1932-33 (Tamil, Telugu, Canarese and Malayalam).	Ditto .	Ditto.
26	Villagers' Calendar for 1931, 1932 and 1933 (English).	Ditto .	Ditto.
27	Handbill on Cotton (Tamil) .	K. Raghavachary . .	Ditto.
28	Useful information obtained from 10 years' work 1920-29, on the Agricultural Research Station, Samalkota (English and Telugu). Pamphlet No. 4 of the Department of Agriculture, Madras.	G. Jogi Raju . .	Ditto.
29	Sow good seed (Malayalam, English, Tamil, Telugu and Kanarese). Broadhints No. 5 of the Department of Agriculture, Madras.	G. R. Hilson . .	Ditto.
30	Beware of Weeds (English, Tamil, Telugu, Kanarese and Malayalam). Broadhints No. 6 of the Department of Agriculture, Madras.	Ditto .	Ditto.
31	Hints to the ryots of Trichinopoly and Tanjore Districts in keeping up the purity of paddy seeds (English and Tamil). Note No. 6 of the Department of Agriculture, Madras.	N. S. Kulandaiswami Pillai.	Ditto.
32	Pure Paddy Seed, II Circle (English and Tamil). Note No. 7 of the Department of Agriculture, Madras.	D. Balakrishnamurthi .	Ditto.
33	What the ryot should do in Malabar and South Canara to produce pure paddy (English, Malayalam and Kanarese). Note No. 8 of the Department of Agriculture, Madras.	Issued by the Department of Agriculture, Madras.	Ditto.

List of Agricultural Publications in India during 1931-33—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE—*contd.*		
34	How to save Temples and costly Buildings from destruction. Note No. 9 of the Department of Agriculture, Madras.	S. Sundararama Ayyar	Government Press, Madras.
35	Maintenance and preservation of pure paddy seed in Ceded District. Note No. 10 of the Department of Agriculture, Madras.	Issued by the Department of Agriculture, Madras.	Ditto.
36	Water Hyacinth (English, Tamil, Telugu, Kanarese, Malayalam and Oriya). Leaflet No. 38 of the Department of Agriculture, Madras.	Ditto	Ditto.
37	Early Sowing of Cambodia Cotton (English and Tamil). Leaflet No. 45 of the Department of Agriculture, Madras.	V. Ramanatha Ayyar	Ditto.
38	Note on Cashew-nut (English, Tamil, Telugu, Kanarese and Malayalam). Leaflet No. 47 of the Department of Agriculture, Madras.	M. K. Nambiar and J. S. Patel.	Ditto.
39	South Indian Weeds (English) (Book).	C. Tadulingam and G. V. Narayana.	Ditto.
40	Tamil Sayings and Proverbs on Agriculture (Tamil). Bulletin No. 29 of the Department of Agriculture, Madras.	Issued by the Department of Agriculture, Madras.	Ditto.
41	Telugu Sayings on Agriculture (Telugu). Bulletin No. 31 of the Department of Agriculture, Madras.	Ditto	Ditto.
42	Kanarese Proverbs on Agriculture (Kanarese). Bulletin No. 35 of the Department of Agriculture, Madras.	Ditto	Ditto.
43	Pulichai Cotton (Tamil). Handbill of the Department of Agriculture, Madras.	Ditto	Ditto.
44	Annual Report of the Department of Agriculture in the Bombay Presidency for the year 1930-31. Price, As. 10 or 1s. 1d.	Issued by the Department of Agriculture, Bombay.	Government Central Press, Bombay.

List of Agricultural Publications in India during 1931-33—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE—*contd.*		
45	Annual Report of the Department of Agriculture in the Bombay Presidency for the year 1931-32. Price, Re. 1-1 or 1*s.* 10*d.*	Issued by the Department of Agriculture, Bombay.	Government Central Press, Bombay.
46	Methods of Field and Orchard Irrigation. Leaflet No. 3 (1931) of the Department of Agriculture, Bombay.	Ditto	Ditto.
47	Loranthus. Leaflet No. 4 (1931) of the Department of Agriculture, Bombay.	Ditto	Ditto.
48	Cultivation of Spanish Peanuts. Leaflet No. 6 (1931) of the Department of Agriculture, Bombay.	Ditto	Ditto.
49	Improved Strains of Kolamba rice for the North Konkan. Leaflet No. 9 (1931) of the Department of Agriculture, Bombay.	Ditto	Ditto.
50	Bansi Wheat of the Bombay Deccan and its Improvement. Bulletin No. 166 (1931) of the Department of Agriculture, Bombay Presidency. Price, As. 2.	B. Nazareth	Ditto.
51	Improvement of Manat Lands in the North Konkan. Bulletin No. 167 (1931) of the Department of Agriculture, Bombay. Price, As. 2.	V. G. Gokhale and K. B. Modi.	Ditto.
52	Preliminary Studies of Important Crops in the Bombay Deccan in the Post-war period. Bulletin No. 168 (1932) of the Department of Agriculture, Bombay.	P. C. Patil, T. G. Shirname, T. B. Pawar and K. M. Shah.	Ditto.
53	Annual Report of the Department of Agriculture, Bengal, for the year 1930-31. Price, Rs. 4 or 6*s.* 9*d.*	Issued by the Department of Agriculture, Bengal.	Bengal Secretariat Book Depôt, Calcutta.
54	Annual Report of the Department of Agriculture, Bengal, for the year 1931-32. Price, Re. 1-1 or 1*s.* 9*d.*	Ditto	Ditto.

List of Agricultural Publications in India during 1931-33—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE—*contd.*		
55	Quinquennial Report of the Department of Agriculture, Bengal, on the Crop Cutting Experiments for the years 1927-28 to 1931-32.	Issued by the Department of Agriculture, Bengal.	Bengal Secretariat Book Depôt, Calcutta.
56	A Short Note on Seed Testing (English and Bengali). Leaflet No. 11 (1931) of the Department of Agriculture, Bengal.	Ditto .	Ditto.
57	Paddy (Bengali). Leaflet No. 4 (1932) of the Department of Agriculture, Bengal.	Ditto .	Ditto.
58	Notes on Cultivation of *Cheena* Millet and its Use (English and Bengali).	Ditto .	Ditto.
59	Report on the Administration of the Department of Agriculture, United Provinces of Agra and Oudh, for the 30th June 1931. Price, As. 8.	Issued by the Department of Agriculture, United Provinces.	Superintendent, Government Printing and Stationery, United Provinces, Allahabad.
60	Report on the Administration of the Department of Agriculture, United Provinces of Agra and Oudh, for the year ending 30th June 1932. Price, As. 9.	Ditto .	Ditto.
61	Further Experiments in Electro-Farming. Bulletin No. 61 of the Department of Agriculture, United Provinces.	S. S. Nehru . . .	Ditto.
62	New Experiments in Electro-Farming. Bulletin No. 62 of the Department of Agriculture, United Provinces.	Ditto .	Ditto.
63	Storage of Potato (Urdu and Hindi).	P. K. Dey . . .	Ditto.
64	Report on the Operations of the Department of Agriculture, Punjab, for the year ending 30th June 1931. Part I. Price, Re. 1-4 or 1*s.* 11*d.*	Issued by the Department of Agriculture, Punjab.	Government Printing, Punjab, Lahore.
65	Report on the Operations of the Department of Agriculture, Punjab, for the year ending 30th June 1932. Part I. Price, Re. 1 or 1*s.* 6*d.*	Ditto .	Ditto.

List of Agricultural Publications in India during 1931-33—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE—*contd.*		
66	Annual Report of the Agricultural Station, Gurdaspur, for the year ending 30th June 1930. Price, As. 5.	Issued by the Department of Agriculture, Punjab.	Government Printing, Punjab, Lahore.
67	Experiments at the Agricultural Station, Gurdaspur. Price, As. 12.	Ditto	Ditto.
68	Annual Report of the Agricultural Station, Hansi, for the year ending 30th June 1930. Price, Rs. 3.	Ditto	Ditto.
69	Annual Report of the Agricultural Experimental Farm, Sirsa, for the year ending 30th June 1930. Price, Re. 1-2.	Ditto	Ditto.
70	Annual Report of the Deputy Director of Agriculture, Lyallpur, for the year ending 30th June 1930. Price, Rs. 6-4.	Ditto	Ditto.
71	Annual Report of the Montgomery Agricultural Station for the year ending 30th June 1930. Price, Rs. 3.	Ditto	Ditto.
72	Annual Report of the Deputy Director of Agriculture, Multan, for the year ending 30th June 1930. Price, Rs. 2.	Ditto	Ditto.
73	Annual Report of the Agricultural Station, Rawalpindi, for the year ending 30th June 1930. Price, Re. 1.	Ditto	Ditto.
74	Annual Report of the Agricultural Station, Sargodha, for the year ending 30th June 1930. Price, Re. 1-8.	Ditto	Ditto.
75	Annual Report of the Seed and Experimental Farm, Sargodha, for the year ending 30th June 1930. Price, As. 12.	Ditto	Ditto.
76	On Tea Cultivation in the Punjab. Leaflet No. 99 of the Department of Agriculture, Punjab.	Ditto	Ditto.
77	Punjab 9-D Wheat. Leaflet No. 104 of the Department of Agriculture, Punjab.	Ditto	Ditto.

List of Agricultural Publications in India during 1931-33—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE—*contd.*		
78	Best Varieties of Wheat and Barley for late sowing in the Punjab. Leaflet No. 105 of the Department of Agriculture, Punjab.	Issued by the Department of Agriculture, Punjab.	Government Printing, Punjab, Lahore.
79	Report on the Operations of the Department of Agriculture, Burma, for the year ended 31st March 1931. Price, Re. 1-8 or 2*s.* 3*d.*	Issued by the Department of Agriculture, Burma.	Government Printing and Stationery, Burma, Rangoon.
80	Report on the Operations of the Department of Agriculture, Burma, for the year ended 31st March 1932. Price, Re. 1-8 or 2*s.* 3*d.*	Ditto .	Ditto.
81	The Potato in the Southern Shan States. Agricultural Survey No. 10 of the Department of Agriculture, Burma.	Ditto .	Ditto.
82	Groundnut in Burma. Agricultural Survey No. 11 of the Department of Agriculture, Burma.	Ditto .	Ditto.
83	Tobacco in Burma. Agricultural Survey No. 12 of the Department of Agriculture, Burma.	Ditto .	Ditto.
84	Sesamum in Burma. Agricultural Survey No. 16 of the Department of Agriculture, Burma.	Ditto .	Ditto.
85	The Rice Crop in Burma. Agricultural Survey No. 17 of the Department of Agriculture, Burma.	Ditto .	Ditto.
86	Report of the Agricultural Department, Bihar and Orissa, for the period 1st April 1930 to 31st March 1931. Price, Rs. 2.	Issued by the Department of Agriculture, Bihar and Orissa.	Government Press, Bihar and Orissa, Patna.
87	Annual Report of the Department of Agriculture, Bihar and Orissa, for the period 1st April 1931 to 31st March 1932. Price, Rs. 2-6.	Ditto .	Ditto.

List of Agricultural Publications in India during 1931-33—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE—*contd.*		
88	Annual Report on Experimental Stations in Bihar and Orissa, 1929-30. Price, Rs. 6.	Issued by the Department of Agriculture, Bihar and Orissa.	Government Press, Bihar and Orissa, Patna.
89	Annual Report on Experimental Stations in Bihar and Orissa, 1930-31.	Ditto .	Ditto.
90	Annual Report on Experimental Farms in Bihar and Orissa, 1930-31. Price, Rs. 6.	Ditto .	Ditto.
91	Annual Report on Experimental Farms in Bihar and Orissa, 1931-32. Price, Rs. 6-12.	Ditto .	Ditto.
92	The lines of work and the results achieved at Central Experimental Farm, Cuttack. Bulletin No. 6 (1932) of the Department of Agriculture, Bihar and Orissa.	Ditto	Ditto.
93	Kanke Government Farm. Bulletin No. 8 (1932) of the Department of Agriculture, Bihar and Orissa.	Ditto .	Ditto.
94	Note on the working of Byreah Farm. Bulletin No. 11 (1932) of the Department of Agriculture, Bihar and Orissa.	Ditto .	Ditto.
95	Cultivation and Curing of *Ganja*. Bulletin No. 13 (1932) of the Department of Agriculture, Bihar and Orissa.	Ditto .	Ditto.
96	Dalua Paddy of Orissa (English and Oriya). Leaflet No. 3 (1931) of the Department of Agriculture, Bihar and Orissa.	Ditto .	Ditto.
97	Improved varieties of Paddies recommended for Orissa. Leaflet No. 4 (1932) of the Department of Agriculture, Bihar and Orissa.	Ditto .	Ditto.
98	Some Agricultural Problems of the Flooded Tracts of Orissa and Some Remedies for them. Leaflet No. 6 (1932) of the Department of Agriculture, Bihar and Orissa.	Ditto .	Ditto.

List of Agricultural Publications in India during 1931-33—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE—*contd.*		
99	Report of the (1) Agricultural College, Nagpur, (2) Chemical, Botanical, Mycological and Entomological Research, (3) Agricultural Engineer's Section, (4) Maharajbagh Menagerie together with the external work of the Veterinary Inspector attached to the Agricultural College, Nagpur, for the year ending 31st March 1931. Price, Re. 1-8.	Issued by the Department of Agriculture, Central Provinces.	Government Printing, Central Provinces, Nagpur.
100	Report of the (1) Agricultural College, Nagpur, (2) Chemical, Botanical, Mycological and Entomological Research, (3) Agricultural Engineer's Section, (4) Maharajbagh Menagerie together with the external work of the Veterinary Inspector attached to the Agricultural College, Nagpur, for the year ending 31st March 1932.	Ditto	Ditto.
101	Report on the working of the Department of Agriculture of the Central Provinces for the year ending 31st March 1931.	Ditto	Ditto
102	Report on the working of the Department of Agriculture of the Central Provinces for the year ending 31st March 1932. Price, Re. 1-8.	Ditto	Ditto
103	Quinquennial Report of the Experimental work of the Department of Agriculture, Central Provinces and Berar, for the period 1925-30.	Ditto	Ditto
104	Report on Demonstration Work carried out in the Eastern Circle, Central Provinces, together with Reports on the Seed and Demonstration Farms at Chandkhuri, Bilaspur and Drug with that of Cattle-Breeding Stations of the Circle for the year ending 31st March 1931. Price, Re. 1-8.	Ditto	Ditto

List of Agricultural Publications in India during 1931-33—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE—*contd.*		
105	Report on Demonstration Work carried out in the Eastern Circle, Central Provinces, together with Reports on the Seed and Demonstration and Cattle-Breeding Farms of the Circle for the year ending 31st March 1932. Price, Re. 1-8.	Issued by the Department of Agriculture, Central Provinces.	Government Printing, Central Provinces, Nagpur.
106	Report on the Demonstration Work carried out in the Western Circle, Central Provinces, together with Reports on the Seed and Demonstration and Cattle-Breeding Farms of that Circle for the year ending 31st March 1931, Vol. I (Re. 1) and Vol. II (Re. 1-8).	Ditto	Ditto.
107	Report on the Demonstration Work carried out in the Western Circle, Central Provinces, together with Reports on the Seed and Demonstration and Cattle-Breeding Farms of that Circle for the year ending 31st March 1932.	Ditto	Ditto.
108	Report on the Demonstration Work carried out in the Southern Circle, Central Provinces, together with Reports on the Seed and Demonstration Farms, Warseoni and Sindwahi, for the year ending 31st March 1931. Price, Re. 1-8.	Ditto	Ditto.
109	Report on the Demonstration Work carried out in the Southern Circle, Central Provinces, together with Reports on the Seed and Demonstration and Cattle-Breeding Farms of the Circle for the year ending 31st March 1932. Price, Re. 1-8.	Ditto	Ditto.
110	Report on the Demonstration Work carried out in the Northern Circle, Central Provinces, together with Reports on Seed and Demonstration Farms for the year ending 31st March 1931. Price, Re. 1-8.	Ditto	Ditto.

List of Agricultural Publications in India during 1931-33—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE—*contd.*		
111	Report on the Demonstration Work carried out in the Northern Circle, Central Provinces, together with Reports on Seed and Demonstration Farms for the year ending 31st March 1932. Price, Re. 1-8.	Issued by the Department of Agriculture, Central Provinces.	Government Printing, Central Provinces, Nagpur.
112	Annual Reports of Experimental Farms, Akola, and the Experimental Farm attached to the Agricultural College, Nagpur, for the year ending 31st March 1931. Price, Re. 1-8.	Ditto	Ditto.
113	Annual Reports of Experimental Farms, Akola, and the Experimental Farm attached to the Agricultural College, Nagpur, for the year ending 31st March 1932.	Ditto	Ditto.
114	Annual Reports of Experimental Farms of the Southern and Eastern Circles (Tharsa and Raipur), Central Provinces, for the year ending 31st March 1931. Price, Re. 1.	Ditto	Ditto.
115	Annual Reports of Experimental Farms of the Southern and Eastern Circles (Tharsa and Raipur), Central Provinces, for the year ending 31st March 1932.	Ditto	Ditto.
116	Annual Reports of Experimental Farms of Northern and Plateau Circles (Powarkhera, Adhartal, Chhindwara), with that of Cattle Breeding Stations attached thereto, for the year ending 31st March 1931. Price, Re. 1-8.	Ditto	Ditto.
117	Annual Reports of Experimental Farms of Northern and Plateau Circles (Powarkhera, Adhartal, Chhindwara), with that of Cattle Breeding Stations attached thereto, for the year ending 31st March 1932.	Ditto	Ditto.

List of Agricultural Publications in India during 1931-33—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE—*contd.*		
118	Report on Demonstration Work carried out in the North-Western and Plateau Circle, Central Provinces, together with the Reports on the Seed and Demonstration and Cattle-Breeding Farms for that Circle for the year ending 31st March 1931. Price, Re. 1-8.	Issued by the Department of Agriculture, Central Provinces.	Government Printing, Central Provinces, Nagpur.
119	Report on Demonstration Work carried out in the Northern Circle, Central Provinces, together with the Reports on Seed and Demonstration Farms for the year ending 31st March 1931.	Ditto	Ditto.
120	A Leaflet on the Verum Cotton No. 262, and care of its Seeds (Hindi).	Ditto	Ditto.
121	A Leaflet on Important Suggestions to the Cultivators in Berar (Marathi).	Ditto	Ditto.
122	Weeds (Marathi). Bulletin No. 7 (1933) of the Department of Agriculture, Central Provinces.	Ditto	Ditto.
123	Annual Report of the Department of Agriculture, Assam, for the year 1931-32. Price, Re. 1-6 or 2*s*.	Issued by the Department of Agriculture, Assam.	Government Press, Shillong.
124	Annual Report of the Department of Agriculture, Assam, for the year 1932-33. Price, Re. 1-8 or 2*s*. 3*d*.	Ditto	Ditto.
125	Cultivation of Tobacco (Assamese and Bengali). Leaflet No. 1 (1932) of the Department of Agriculture, Assam.	Ditto	Ditto.
126	Cultivation of Vegetables (Assamese and Bengali). Leaflet No. 2 (1932) of the Department of Agriculture, Assam.	Ditto	Ditto.
127	Annual Report of the Department of Agriculture in Sind for the year 1930-31. Price, As. 4 or 5*d*.	Issued by the Chief Agricultural Officer in Sind.	Government Central Press, Bombay.

List of Agricultural Publications in India during 1931-33—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE—*contd.*		
128	Annual Report of the Department of Agriculture in Sind for the year 1931-32. Price, As. 5 or 6*d*.	Issued by the Chief Agricultural Officer in Sind.	Government Central Press, Bombay.
129	Report on Staff Conference held at Sakrand.	Ditto .	Ditto.
130	Annual Report of the Department of Agriculture, North-West Frontier Province, for 1931-32.	Issued by the Agricultural Officer, North-West Frontier Province.	Government Printing and Stationery, North-West Frontier Province, Peshawar.
131	Report of the Agricultural Stations at Tarnab and Haripur in the North-West Frontier Province for the year ending 30th June 1932.	Ditto .	Ditto.
132	Report of the Mysore Agricultural Department for the year ending 30th June 1931.	Issued by the Director of Agriculture, Mysore.	Government Printing, Bangalore.
133	Report of the Mysore Agricultural Department for the year ending 30th June 1932.	Ditto .	Ditto.
134	Annual Report of the Coffee Scientific Officer, 1931-32. Mysore Coffee Experiment Station. Bulletin No. 7.	Issued by the Mysore Department of Agriculture.	State Press, Bangalore.
135	Report of Work on the Coffee Experiment Station, Balehonnur, for the year 1930-31. Mysore Coffee Experiment Station. Bulletin No. 8.	Ditto .	Ditto.
136	Method to be adopted for the cultivation of *Ragi* in the Irwin Canal Area (Kannada).	Ditto .	Ditto.
137	Method to be adopted for the cultivation of Groundnut in the Irwin Canal Area (Kannada).	Ditto .	Ditto.
138	Annual Administration Report of the Department of Agriculture, H. E. H. the Nizam's Government, for the year 1340 Fasli (6th June 1930 to 6th June 1931), with the Government Review thereon.	Director of Agriculture, H. E. H. the Nizam's Government.	Superintendent, Government Central Press, Hyderabd-Deccan.

List of Agricultural Publications in India during 1931-33—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE—*contd.*		
139	Annual Administration Report of the Department of Agriculture, H. E. H. the Nizam's Government, for the year 1341 Fasli (7th June 1931 to 5th June 1932), with the Review of Government thereon.	Director of Agriculture, H. E. H. the Nizam's Government.	Superintendent, Government Central Press, Hyderabad-Deccan.
140	Annual Report of the Department of Agriculture, Baroda, for the year 1930-31. Price, Re. 1-14-6.	Director of Agriculture, Baroda State.	Baroda State Press.
141	Annual Report of the Department of Agriculture, Baroda, for the year 1931-32. Price, Re. 1-6.	Ditto .	Ditto.
142	Report on the Administration of the Agricultural Department in the Cochin State for the year 1107 (1931-32).	Superintendent of Agriculture, Trichur.	Cochin Government Press, Ernaculam.
143	Report on the Administration of the Department of Agriculture and Fisheries, Travancore, for the year 1106 M. E. (1930-31).	Director of Agriculture and Fisheries, Travancore.	Travancore State Press.
144	Groundnut Cultivation. Leaflet of the Department of Agriculture, Travancore.	Issued by the Department of Agriculture, Travancore.	Ditto.
145	Care of Pepper vine. Leaflet of the Department of Agriculture, Travancore.	Ditto .	Ditto.
146	The Propagation of Lime Trees by Gooty Method. Leaflet of the Department of Agriculture, Travancore.	Ditto .	Ditto.
147	The Cultivation of Sunnhemp at Ayikudy. Leaflet of the Department of Agriculture, Travancore.	Ditto .	Ditto.
148	Principles of Dry Farming. Leaflet of the Department of Agriculture, Travancore.	Ditto .	Ditto.
149	Improvements in Paddy Cultivation in North Travancore. Leaflet of the Department of Agriculture, Travancore.	Ditto .	Ditto.

List of Agricultural Publications in India during 1931-33—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE—*concld.*		
150	The Economic Value of *Calotropis gigantia*. Leaflet of the Department of Agriculture, Travancore.	Issued by the Department of Agriculture, Travancore.	Travancore State Press.
151	A Note on the Emergence of Panicles in the Variety of Paddy known as 'Valasarmundan'. Leaflet of the Department of Agriculture, Travancore.	Ditto .	Ditto.
152	A Note on the Shock-reaction phenomenon consequent on the frequent lifting and transplanting of seedlings raised from selected seeds of Valasarmundan paddy. Leaflet of the Department of Agriculture, Travancore.	Ditto .	Ditto.
153	A Note on Viability Tests conducted with Shade-dried Germinated Seeds of Paddy Variety 'Samba'. Leaflet of the Department of Agriculture, Travancore.	Ditto .	Ditto.
	AGRICULTURAL ENGINEERING		
154	On Multiple Sardar Furnace for the Manufacture of *Gur*, *Shakkar* and *Rab*. Leaflet No. 100 of the Department of Agriculture, Punjab.	Issued by the Department of Agriculture, Punjab.	Government Printing, Punjab, Lahore.
155	Improved Theikpan Long Furnace. Cultivators' Leaflet No. 69 of the Department of Agriculture, Burma.	Issued by the Department of Agriculture, Burma.	Government Printing and Stationery, Burma, Rangoon.
156	The Norag—a Cheap and Efficient Bullock-driven Threshing Implement. Bulletin No. 5 (1932) of the Department of Agriculture, Bihar and Orissa.	Issued by the Department of Agriculture, Bihar and Orissa.	Government Press, Bihar and Orissa, Gulzarbagh.
157	A Short Note on the Activities of the Agricultural Engineering Section. Bulletin No. 15 (1932) of the Department of Agriculture, Bihar and Orissa.	Ditto .	Ditto.
158	Water Lifts in Bihar and Orissa	Ditto .	Ditto.

List of Agricultural Publications in India during 1931-33—contd.

No.	Title	Author	Where published
	AGRICULTURAL ENGINEERING—*contd.*		
159	Ploughs and Ploughing—a Survey of the Ploughs tested on Departmental Farms and the Progress of the Inversion Plough over the last 50 years under the conditions prevalent in the Central Provinces. Bulletin No. 24 (1932) of the Department of Agriculture, Central Provinces.	Issued by the Department of Agriculture, Central Provinces.	Government Printing, Central Provinces, Nagpur.
160	Harvesting and Threshing Machinery in the Central Provinces. Bulletin No. 25 (1932).	Ditto	Ditto.
161	Agricultural Implements and their Description to be used in the Irwin Canal Area (Kannada). Leaflet of the Department of Agriculture, Travancore.	Issued by the Department of Agriculture, Travancore.	Travancore State Press.
	AGRICULTURAL STATISTICS		
162	Estimates of Area and Yield of Principal Crops in India 1931-32. Price, Rs. 2-6-0 or 4*s*. 3*d*.	Issued by the Department of Commercial Intelligence and Statistics, Calcutta.	Manager of Publications, Delhi.
163	Estimates of Area and Yield of Principal Crops in India 1932-33. Price, Re. 1-4-0 or 2*s*.	Ditto	Ditto.
164	Agricultural Statistics of India, Vol. I. British India for 1930-31. Price, Rs. 8-4-0 or 14*s*.	Ditto	Ditto.
165	Agricultural Statistics of India, Vol. II—Indian States for 1929-30. Price, Re. 1-10 or 2*s*. 9*d*.	Ditto	Ditto.
166	Indian Tea Statistics, 1932. Price, As. 6 or 8*d*.	Ditto	Ditto.
167	Indian Rubber Statistics, 1932. Price, As. 6 or 8*d*.	Ditto	Ditto.
168	Indian Coffee Statistics, 1931-32. Price, As. 2 or 3*d*.	Ditto	Ditto.
169	Livestock Statistics, India, 1929-30 (Quinquennial). Price, As. 4 or 5*d*.	Ditto	Ditto.
170	Review of the Sugar Industry of India, 1931-32. Price, Anna 1.	Ditto	Ditto.

List of Agricultural Publications in India during 1931-33—contd.

No.	Title	Author	Where published
	AGRICULTURAL STATISTICS—*contd.*		
171	Season and Crop Report of the Madras Presidency for the year 1930-31.	Issued by the Department of Agriculture, Madras.	Government Press, Madras.
172	Season and Crop Report of the Madras Presidency for the year 1931-32.	Ditto .	Ditto.
173	Season and Crop Report of the Bombay Presidency for the year 1930-31. Price, As. 7 or 9*d*.	Issued by the Department of Agriculture, Bombay.	Government Central Press, Bombay.
174	Season and Crop Report of the Bombay Presidency for the year 1931-32. Price, As. 7 or 9*d*.	Ditto .	Ditto.
175	Season and Crop Report of Bengal for 1930-31.	Issued by the Department of Agriculture, Bengal.	Bengal Secretariat Book Depot, Calcutta.
176	Season and Crop Report of Bengal for 1931-32.	Ditto .	Ditto.
177	Season and Crop Report of the United Provinces of Agra and Oudh for the year 1930-31. Price, Re. 1-4.	Issued by the Department of Land Records, United Provinces.	Superintendent, Government Printing and Stationery, United Provinces, Allahabad.
178	Season and Crop Report of the United Provinces of Agra and Oudh for the year 1931-32. Price, Re. 1-4.	Ditto .	Ditto.
179	Report on the Season and Crops of the Punjab for the Agricultural year ending 30th June 1931. Price, Rs. 3-8-0 or 4*s*. 8*d*.	Issued by the Department of Agriculture, Punjab.	Government Printing, Punjab, Lahore.
180	Report on the Season and Crops of the Punjab for the Agricultural year ending 30th June 1932. Price, Rs. 4-8-0 per copy.	Ditto .	Ditto.
181	Tables of Agricultural Statistics of the Punjab for the year 1930-31.	Ditto .	Ditto.
182	Tables of Agricultural Statistics of the Punjab for the year 1931-32.	Ditto .	Ditto.

List of Agricultural Publications in India during 1931-33—contd.

No.	Title	Author	Where published
	AGRICULTURAL STATISTICS—*concld.*		
183	Season and Crop Report of Burma for the year ending 30th June 1931. Price, Re. 1-8-0 or 2*s.* 3*d.*	Issued by the Commissioner of Settlements and Land Records, Burma.	Government Printing and Stationery, Burma, Rangoon.
184	Season and Crop Report of Burma for the year ending 30th June 1932. Price, Re. 1-8 or 2*s.* 3*d.*	Ditto	Ditto.
185	Season and Crop Report of the Department of Agriculture, Bihar and Orissa for 1930-31.	Issued by the Department of Agriculture, Bihar and Orissa.	Government Printing, Bihar and Orissa, Patna.
186	Season and Crop Report of the Department of Agriculture, Bihar and Orissa for 1931-32. Price, Rs. 2-4.	Ditto	Ditto.
187	Agricultural Statistics of Bihar and Orissa for 1930-31. Price, Rs. 2.	Ditto	Ditto.
188	Agricultural Statistics of Bihar and Orissa for 1931-32.	Ditto	Ditto.
189	Season and Crop Report of the Central Provinces and Berar for the year ending 31st May 1931. Price, Re. 1-8-0.	Issued by the Director of Land Records, Central Provinces.	Government Printing, Central Provinces, Nagpur.
190	Season and Crop Report of the Central Provinces and Berar for the year ending 31st May 1932. Price, Re. 1-8.	Ditto	Ditto.
191	Report on the Season and Crops of the North-West Frontier Province for the year 1931-32. Price, Rs. 3-13 or 6*s.* 6*d.*	Revenue and Divisional Commissioner, North-West Frontier Province.	Government Printing and Stationery, North-West Frontier Province, Peshawar.
	AGRICULTURAL ECONOMICS		
192	Principles and Practice of Farm Costing with Farm Studies.	P. C. Patil and T. B. Pawar.	Government Central Press, Bombay.
193	Note on Burma Rice Prices. An Enquiry into the Reasons for the present Market Depression. Agricultural Survey No. 14 of the Department of Agriculture, Burma.	Issued by the Department of Agriculture, Burma.	Government Printing and Stationery Burma, Rangoon.
194	Rice Crop in Burma—its History, Cultivation, Marketing and Improvement.	Ditto	Ditto.

List of Agricultural Publications in India during 1931-33—contd.

No.	Title	Author	Where published
	AGRICULTURAL ECONOMICS—*contd.*		
195	Report of the Deputy Director of Agriculture, Economics and Marketing, Central Provinces, for the year 1930-31. Price, Re. 1-4-0.	Issued by the Department of Agriculture, Central Provinces.	Government Printings, Central Provinces, Nagpur.
196	A Note on Sales of Land between the Notified Agricultural Tribes in the Punjab during the Quinquennium 1922-23 to 1926-27 (Punjab Board of Economic Inquiry Publication No. 23). Price, As. 6.	Cyril P. K. ; Fazal, M.A., with a foreword by H. Calvert, B.Sc., C.I.E., I.C.S.	Civil and Military Gazette, Ltd., Lahore.
197	Farm Accounts in the Punjab, 1929-30 (Punjab Board of Economic Inquiry Publication No. 24). Price, Rs. 2.	Kartar Singh, B.Sc., L.Ag.	Ditto.
198	Cost of Milk Production at Lyallpur (Punjab Board of Economic Inquiry Publication No. 25). Price, As. 4.	D. P. Johnston, I.A.S. and Kartar Singh, B.Sc., L.Ag.	Ditto.
199	Farm Accounts in the Punjab, 1930-31 (Punjab Board of Economic Inquiry Publication No. 26). Price, Rs. 2.	Kartar Singh, B.Sc., L.Ag.	Ditto.
200	Punjab Village Surveys, No. 4—Kala Gaddi Thamman, a village in the Lyallpur District (Punjab Board of Economic Inquiry Publication No. 27). Price, Rs. 4.	Randhir Singh under the supervision of W. Roberts, B.Sc.	Ditto.
201	Milk Supply of Lahore in 1930 (Punjab Board of Economic Inquiry Publication No. 28). Price, Rs. 2.	R. L. Anand, M.A., under the supervision of A. C. Agarwala, B.Sc., M.R.C.V.S.	Ditto.
202	Food Consumption by Zemindars in Khanewal Tahsil of the Multan District (Punjab Board of Economic Inquiry Publication No. 29).	Sardari Lal, B.A., under the supervision of W. Roberts, B.Sc.	Ditto.
203	Punjab Village Surveys, No. 5—Naggal, a village in the Ambala District (Punjab Board of Economic Inquiry Publication No. 30). Price, Rs. 4.	Sher Singh under the supervision of H. Fyson, I.C.S.	Ditto.

List of Agricultural Publications in India during 1931-33—contd.

No.	Title	Author	Where published
	SUGAR RESEARCH		
204	The Open-Pan System of White Sugar Manufacture. Scientific Monograph No. 3 of the Imperial Council of Agricultural Research. Price, Rs. 3-2-0 or 5*s.* 6*d.*	R. C. Srivastava . .	Manager of Publications, Delhi.
205	Improvement of Sugarcane Seed (English and Telugu). Leaflet No. 17 of the Department of Agriculture, Madras.	A. C. Edmonds . .	Government Press, Madras.
206	The Cultivation of Coimbatore Seedling Sugarcane in South India (English and Telugu). Bulletin No. 30 of the Department of Agriculture, Madras. Price, As. 4.	A. C. Edmonds, S. Sitarama Patrudu and M. Ramamurty.	Ditto.
207	Scum Strainer in *Gul* Boiling. Leaflet No. 12 (1932) of the Department of Agriculture, Bombay.	Issued by the Department of Agriculture, Bombay.	Government Central Press, Bombay.
208	Sugar Manufacture by the Open-Pan System. Leaflet No. 2 (1933) of the Department of Agriculture, Bombay.	Ditto .	Ditto.
209	Notes on Power Crushing of Sugarcane in Improved Mills for the Manufacture of *Gur* (English and Bengali). Leaflet No. 6 (1931) of the Department of Agriculture, Bengal.	Issued by the Department of Agriculture, Bengal.	Bengal Secretariat Book Depot, Calcutta.
210	Notes on Sugarcane Cultivation and *Gur* and Sugar Manufacture. Leaflet No. 5 (1932) of the Department of Agriculture, Bengal.	Ditto .	Ditto.
211	Points to be noted in *Gur* making (English and Bengali). Leaflet No. 1 (1933) of the Department of Agriculture, Bengal.	Ditto .	Ditto.
212	Flowering of Cane (Urdu and Hindi).	R. G. Allan . . .	Superintendent, Government Printing and Stationery, United Provinces, Allahabad.
213	Problem of Cane Crushing and Sugar Manufacture (English, Hindi and Urdu).	N. C. Mehta . .	Ditto.
214	Advantages of Early Sowing of Cane (Urdu and Hindi).	R. G. Allan . . .	Ditto.

List of Agricultural Publications in India during 1931-33—contd.

No.	Title	Author	Where published
	SUGAR RESEARCH—*contd.*		
215	Sugarcane Survey in the Punjab. Leaflet No. 106 of the Department of Agriculture, Punjab.	Issued by the Department of Agriculture, Punjab.	Government Printing, Punjab, Lahore.
216	Manufacture of S. S. B. Sugar and Construction of an Improved Furnace for Boiling Juice. Bulletin No. 2 of the Department of Agriculture, Bihar and Orissa.	Issued by the Department of Agriculture, Bihar and Orissa.	Government Press, Bihar and Orissa, Patna.
217	The Manufacture of *Gur* and Sugar from the Juice of Palmyra Palm Trees. Bulletin No. 9 (1932) of the Department of Agriculture, Bihar and Orissa.	Ditto .	Ditto.
218	Sugarcane in Orissa—its present position and future prospects. Leaflet No. 7 (1932) of the Department of Agriculture, Bihar and Orissa.	Ditto .	Ditto.
219	Description of terms issued in describing diagnostic and other characters of Sugarcane. Bulletin No. 1 (1933) of the Department of Agriculture, Bihar and Orissa.	Ditto .	Ditto.
220	A Note on the Programme of Work and Results obtained during the year 1932 at the Sugarcane Research Station, Mushari (Muzaffarpur). Bulletin No. 2 (1933) of the Department of Agriculture, Bihar and Orissa.	Ditto .	Ditto
221	A Preliminary Note on the Single-Pan Method of Manufacturing Khandsari Sugar. Bulletin No. 3 (1933) of the Department of Agriculture, Bihar and Orissa.	Ditto .	Ditto.
222	Sugarcane Crushing Mills—its adjusment and care.	Ditto .	Ditto.
223	Method to be adopted for the cultivation of Sugarcane in the Irwin Canal Area (Kannada). Circular No. 48 of the Department of Agriculture, Mysore.	Issued by the Department of Agriculture, Mysore.	State Press, Bangalore.
224	Sugarcane—A Plea for the Introduction of New Varieties. Leaflet of the Department of Agriculture, Travancore.	Issued by the Department of Agriculture, Travancore.	Travancore State Press.

List of Agricultural Publications in India during 1931-33—contd.

No.	Title	Author	Where published
	FRUITS		
225	Graft Mango Gardens—How to start and maintain them. (English and Telugu). Bulletin No. 24 of the Department of Agriculture, Madras.	G. Jogi Raju . .	Government Press, Mount Road, Madras.
226	Selection of a site for an Orange Orchard. Leaflet No. 5 (1931) of the Department of Agriculture, Bombay.	Issued by the Department of Agriculture, Bombay.	Government Central Press, Bombay.
227	Report on the Export of Mango to Europe in 1932. Bulletin No. 170 (1932) of the Department of Agriculture, Bombay. Price, As. 9.	G. S. Cheema and P. G. Dani.	Ditto.
228	How to grow Papaya. Leaflet No. 1 (1932) of the Department of Agriculture, Bombay.	Issued by the Department of Agriculture, Bombay.	Ditto.
229	The Papaya or *Papeeta*. Bulletin No. 60 of the Department of Agriculture, United Provinces.	W. Head . . .	Superintendent, Printing and Stationery, United Provinces, Allahabad.
230	The Planting and Early Care of Young Fruit Trees. The Fruit Series No. 1 of the Department of Agriculture, United Provinces.	Ditto . . .	Ditto.
231	The Papaya or *Papeeta*. Fruit Series No. 2 of the Department of Agriculture, United Provinces.	Ditto . . .	Ditto.
232	Annual Report of the Fruit Specialist to Government, Punjab, Lyallpur, for the year ending 30th June 1930. Price, As. 8.	Issued by the Department of Agriculture, Punjab.	Government Printing, Punjab, Lahore.
233	A Note on Various Varieties of Fruits grown in the Simla Hills.	Ditto .	Ditto.
234	Budding and Top-working of *Ber* Trees. Leaflet No. 95 of the Department of Agriculture, Punjab.	Ditto .	Ditto.
235	Hints on Cultivation of Papaya. Bulletin No. 4 (1932) of the Department of Agriculture, Bihar and Orissa.	Issued by the Department of Agriculture, Bihar and Orissa.	Government Press, Bihar and Orissa, Patna.
236	Leaflet No. 5 of 1932 of the Department of Agriculture, Bihar and Orissa.	Ditto .	Ditto.

List of Agricultural Publications in India during 1931-33—contd.

No.	Title	Author	Where published
	FRUITS—*contd.*		
237	A Leaflet on Manuring of Oranges (English, Hindi and Marathi).	Issued by the Department of Agriculture, Central Provinces.	Government Printing, Central Provinces, Nagpur.
	SERICULTURE		
238	The Silk Industry of Japan, with notes on observations in U. S. A., England, France and Italy. Scientific Monograph No. 8 of the Imperial Council of Agricultural Research. Price, Rs. 4 or 6*s.* 9*d.*	C. C. Ghosh . . .	Manager of Publications, Delhi.
	LAC		
239	Report of the Committee and of the Director, Indian Lac Research Institute, Namkum, Ranchi, for the year 1st April 1930 to 31st March 1931.	Director, Indian Lac Research Institute, Namkum, Ranchi.	Star Printing Works, Calcutta.
240	Annual Report of the Indian Lac Research Institute, Namkum, Ranchi, Bihar and Orissa, for the year 1st April 1931 to 31st March 1932.	Ditto .	Ditto.
241	Some Aspects of the Bionomics of the Lac Insect.	P. S. Negi, M. P. Misra and S. N. Gupta.	Ditto.
242	A Practical Manual of Lac Cultivation.	P. M. Glover . .	Ditto.
243	Enquiry into the Deterioration of Lac Cultivation in the District of Malda and Recommendations for Improvement (English and Bengali). Leaflet No. 3 (1932) of the Department of Agriculture, Bengal.	Issued by the Department of Agriculture, Bengal.	Bengal Secretariat Book Depot, Calcutta.
	COTTON TECHNOLOGY		
244	Technological Report on Standard Indian Cottons, 1931 (Technological Bulletin A—18).	Secretary, Indian Central Cotton Committee, Bombay.	Secretary, Indian Central Cotton Committee, Bombay.
245	Application of different systems of high draft spinning to mixings of Indian Cottons (Technological Bulletin, Series No. A, 19).	R. P. Richardson and Nazir Ahmad.	Ditto.

List of Agricultural Publications in India during 1931-33—contd.

No.	Title	Author	Where published
	COTTON TECHNOLOGY—*contd.*		
246	The Weight per inch of Fibres of Different Lengths and the Numbers of Fibres of Different Lengths per seed for each of the Standard Indian Cottons (Technological Bulletin B-7).	Secretary, Indian Central Cotton Committee, Bombay.	Secretary, Indian Central Cotton Committee, Bombay.
247	The Foundations of Yarn Strength and Yarn Extension: Part IV—The Influence of Yarn Twist on the Diameters of Cotton Yarns and on the Proportions of Fibre-slippage and Fibre-fracture in Yarn-breakage. (Technological Bulletin B-9).	Ditto .	Ditto
248	Studies in the Sampling of Cotton for the Determination of Fibre Properties: Part III —The Size and Reliability of a Satisfactory Sample (Technological Bulletin B-10).	Ditto .	Ditto.
249	Spinning Tests on mixings of long-staple and short-staple Indian Cottons (Technological Bulletin, Series A, No. 20).	Nazir Ahmad . .	Ditto.
250	Technical Report on Standard Indian Cottons, 1932 (Technological Bulletin A-21).	Ditto .	Ditto.
	Spinning Tests Reports on 1930-31 Samples of :—		
251	Dhollera, Westerns, Farm Westerns and Kumpta Cottons (Technological Circular No. 55).	Secretary, Indian Central Cotton Committee, Bombay, and Director, Technological Laboratory.	Ditto.
252	A. R. Kampala, A. R. Busoga and A. R. Jinja Cottons (Technological Circular No. 56).	Ditto .	Ditto.
253	Kalagin, Bijapur and Bagalkote Cottons (Technological Circular No. 57).	Ditto .	Ditto.
254	Upland Cambodia and Karunganni Cottons (Technological Circular No. 58).	Ditto .	Ditto.

List of Agricultural Publications in India during 1931-33—contd.

No.	Title	Author	Where published
	COTTON TECHNOLOGY—*contd.*		
	Spinning Tests Reports on 1931-32 Samples of :—		
255	Dhulia (Khandesh) Cotton (Technological Circular No. 60).	Secretary, Indian Central Cotton Committee, Bombay, and Director, Technological Laboratory.	Secretary, Indian Central Cotton Committee, Bombay.
256	Ujjain Cottons (Technological Circular No. 63).	Ditto . .	Ditto.
257	Khandesh Cottons (Technological Circular No. 64).	Ditto . .	Ditto.
258	Broach (Salar), Bailhougal and Hubli-Kumpta Cottons (Technological Circular No. 69).	Ditto . .	Ditto.
259	Jagadia and Kadi Cottons (Technological Circular No. 70).	Ditto . .	Ditto.
260	Hubli-Kumpta and Hubli-Upland Cotton (Technological Circular No. 71).	Ditto . .	Ditto.
261	C. P. No. 1, Muttra and Berar Cottons (Technological Circular No. 72).	Ditto . .	Ditto.
262	Latur and Nanded Cottons (Technological Circular No. 73).	Ditto . .	Ditto.
263	Surat and Broach Cottons (Technological Circular No. 74).	Ditto . .	Ditto.
264	Punjab-American, Jagadia Farm and Navsari Cottons (Technological Circular No. 75).	Ditto . .	Ditto.
265	Dhollera, Westerns and Kumpta Cottons (Technological Circular No. 76).	Ditto . .	Ditto.
266	Bijapur and Tinnevelly Cottons (Technological Circular No. 77).	Ditto . .	Ditto.
267	Upland Cambodia and Karunganni Cottons (Technological Circular No. 78).	Ditto . .	Ditto.
268	Kadi Viramgan and Khandesh Cottons (Technological Circular No. 79).	Ditto . .	Ditto.
269	Kalagin and Bagalkote Cottons (Technological Circular No. 80).	Ditto . .	Ditto.

List of Agricultural Publications in India during 1931-33—contd.

No.	Title	Author	Where published
	COTTON TECHNOLOGY—*concld.*		
	Technological Reports on 1930-31 Samples of:—		
270	Verum 262 (Akola) Cotton (Technological Circular No. 36).	Secretary, Indian Central Cotton Committee, Bombay, and Director, Technological Laboratory.	Secretary, Indian Central Cotton Committee, Bombay.
271	Verum 262 (Nagpur) (Technological Circular No. 38).	Ditto . .	Ditto.
272	Umri Bani Cotton (Technological Circular No. 41).	Ditto . .	Ditto.
273	Punjab-American 289-F Cotton (Technological Circular No. 42).	Ditto . .	Ditto.
274	Punjab-American 4-F Cotton (Technological Circular No. 43).	Ditto . .	Ditto.
	Technological Reports on 1931-32 Samples of:—		
275	Umri Bani (Technological Circular No. 61).	Ditto . .	Ditto.
276	Verum 262 (Akola) (Technological Circular No. 65).	Ditto . .	Ditto.
277	Punjab-American 289-F (Technological Circular No. 66).	Ditto . .	Ditto.
278	Punjab-American 4-F (Technological Circular No. 67).	Ditto . .	Ditto.
279	Jayawant (Kumpta) (Technological Circular No. 68).	Ditto . .	Ditto.
	AGRICULTURAL SCIENCE		
	General		
280	*The Indian Journal of Agricultural Science*, Vol. I, parts 4, 5 and 6; Vol. II, parts 1 to 6 and Vol. III, parts 1, 2 and 3.	Issued under the authority of the Imperial Council of Agricultural Research.	Manager of Publications, Civil Lines, Delhi.
281	Scientific Reports of the Imperial Institute of Agricultural Research, Pusa (including the Reports of the Imperial Dairy Expert, Physiological Chemist, Government Sugarcane Expert, and Secretary, Sugar Bureau) for 1930-31. Price Rs. 2-6-0 or 4*s.* 3*d.*	Issued under the Authority of the Director, Imperial Institute of Agricultural Research, Pusa.	Ditto.
282	Scientific Report of the Imperial Institute of Agricultural Research, Pusa (including the Reports of the Imperial Dairy Expert, Physiological Chemist and Government Sugarcane Expert), 1931-32. Price, Rs. 2-12 or 5*s.*	Ditto . .	Ditto.

List of Agricultural Publications in India during 1931-33—contd.

No.	Title	Author	Where published
	BOTANY		
283	Influence of Manures on the Wilt Disease of *Cajanus indicus* Spreng and the Isolation of Types Resistant to the disease. Scientific Monograph No. 7 of the Imperial Council of Agricultural Research. Price, Rs. 2-4 or 4*s*. 3*d*.	W. McRae and F. J. F. Shaw.	Manager of Publications, Civil Lines, Delhi.
284	Crop Improvement in Bihar and Orissa. A Summary of Work done in the Botanical Area 1929-32. Bull. No. 16 (1932) of the Department of Agriculture, Bihar and Orissa.	Issued by the Department of Agriculture, Bihar and Orissa.	Government Press, Bihar and Orissa, Patna.
285	A Handbook of some South Indian weeds. Price, Rs. 4.	Rao Bahadur C. Tadulingam Mudaliyar and G. Venkatanarayana.	Government Press, Madras.
	CHEMISTRY		
286	Procedure of getting samples analysed at the Laboratory of the Agricultural Chemist to Government, Poona. Leaflet No. 11 (1931) of the Department of Agriculture, Bombay.	Issued by the Department of Agriculture, Bombay.	Government Central Press, Bombay.
287	Preservation of Cattle Urine as Manure. Leaflet No. 6 (1932) of the Department of Agriculture, Bombay.	Ditto . .	Ditto.
288	A Practical System of Storing Farmyard Manure. Leaflet No. 10 (1932) of the Department of Agriculture, Bombay.	Ditto . .	Ditto.
289	Manures for the Cotton Crop in Khandesh. Leaflet No. 13 (1932) of the Department of Agriculture, Bombay.	Ditto . .	Ditto.
290	The use of Ammonium Sulphate (a compound fertilizer) on Aman Paddy Seedbeds (English and Bengali). Leaflet No. 6 (1932) of the Department of Agriculture, Bengal.	Issued by the Department of Agriculture, Bengal.	Bengal Secretariat Book Depot, Calcutta.
291	Colloids in Agriculture . .	G. R. Saxena . .	Superintendent, Government Printing and Stationery, United Provinces, Allahabad.

List of Agricultural Publications in India during 1931-33—contd.

No.	Title	Author	Where published
	CHEMISTRY—*contd.*		
292	Annual Report of the Agricultural Chemist to Government, Punjab, Lyallpur for the year ending 30th June 1930. Price, Re. 1-2-0.	Issued by the Department of Agriculture, Punjab.	Government Printing, Punjab, Lahore.
293	A Soil Survey of the Pegu District, Burma. Agricultural Survey No. 13 of the Department of Agriculture, Burma.	Issued by the Department of Agriculture, Burma.	Government Printing and Stationery, Burma.
294	A Soil Survey of the Mandalay Canal Area, Burma. Agricultural Survey No. 15 of the Department of Agriculture, Burma.	Ditto . .	Ditto.
295	Manuring of Paddy Nurseries. Cultivators' Leaflet No. 70 of the Department of Agriculture, Burma.	Ditto . .	Ditto.
296	A Short Note on the Work of the Chemical Sections of the Department of Agriculture, Bihar and Orissa. Bulletin No. 10 (1932) of the Department of Agriculture, Bihar and Orissa.	Issued by the Department of Agriculture, Bihar and Orissa.	Government Press, Bihar and Orissa, Patna.
297	Preparation of Artificial Farmyard Manures and Organic Composts as Suppliers of Organic Matter to the Soil. Bulletin No. 3 (1932) of the Department of Agriculture, Bihar and Orissa.	Ditto . .	Ditto.
298	How to Manure your Land Cheap. Leaflet No. 1 (1933) of the Department of Agriculture, Bihar and Orissa.	Ditto . .	Ditto.
299	A Leaflet on an Easy Method of Converting Bones into a Useful Phosphatic Manure (English, Hindi and Marathi).	Issued by the Department of Agriculture, Central Provinces.	Government Printing, Central Provinces, Nagpur.
300	A Leaflet on Preparation of Artificial Farmyard Manure from Surplus Waste Materials from the Fields (English, Hindi and Marathi).	Ditto . .	Ditto.
301	Utilization of Human Excreta as Manure (English, Hindi and Marathi). Bulletin No. 26 (1932) of the Department of Agriculture, Central Provinces.	Ditto . .	Ditto.

List of Agricultural Publications in India during 1931-33—contd.

No.	Title	Author	Where published
	CHEMISTRY—*concld.*		
302	Farmyard Manure (revised). Bulletin No. 3 (1933) of the Department of Agriculture, Central Provinces.	Issued by the Department of Agriculture, Central Provinces.	Government Printing, Central Provinces, Nagpur.
303	Oilcakes—their Uses as Cattle Food and Manure (revised). Bulletin No. 6 (1933) of the Department of Agriculture, Central Provinces.	Ditto . .	Ditto.
304	Organic Manures *versus* Artificials. Leaflet of the Department of Agriculture, Travancore.	Issued by the Department of Agriculture, Travancore.	Travancore State Press.
	PLANT DISEASES		
305	The Fungi of India. Scientific Monograph No. 1 of the Imperial Council of Agricultural Research. Price, Rs. 6-12-0 or 11*s*.	E. J. Butler, and G. R. Bisby.	Manager of Publications, Civil Lines, Delhi.
306	Influence of Manures on the Wilt Disease of *Cajanus indicus* Spreng and the Isolation of Types resistant to the Disease. Scientific Monograph No. 7 of the Imperial Council of Agricultural Research. Price, Rs. 2-4 or 4*s*. 3*d*.	W. McRae and F. J. F. Shaw.	Ditto.
307	Budrot of Palmyra and Coconut Palms (English, Tamil, Telugu, Malayalam and Kanarese). Leaflet No. 36 of the Department of Agriculture, Madras.	S. Sundararama Ayyar .	Government Press, Madras.
308	Mildew on Grapes and How to prevent it (English, Tamil, Telugu, Kanarese and Malayalam). Leaflet No. 37 of the Department of Agriculture, Madras.	Ditto . .	Ditto.
309	Smut Diseases of Cholam and Tenai (English, Tamil, Telugu, Kanarese and Malayalam). Leaflet No. 43 of the Department of Agriculture, Madras.	Ditto . .	Ditto.
310	'Die-back' Disease of Cashew Nuts in the West Coast. Leaflet No. 46 of the Department of Agriculture, Madras.	Ditto . .	Ditto.

List of Agricultural Publications in India during 1931-33—contd.

No.	Title	Author	Where published
	PLANT DISEASES—*contd.*		
311	Some Fungoid Diseases. Bulletin No. 32 of the Department of Agriculture, Madras.	Issued by the Department of Agriculture, Madras.	Government Press, Madras.
312	The Mosaic Disease of Sugarcane (Tamil). Leaflet No. 31 of the Department of Agriculture, Madras.	Ditto . .	Ditto.
313	Sprayers and Spraying. (Tamil and Kanarese). Leaflet No. 34 of the Department of Agriculture, Madras.	Ditto . .	Ditto.
314	Control of Tambera Disease of Potato. Leaflet No. 2 (1931) of the Department of Agriculture, Bombay.	Issued by the Department of Agriculture, Bombay.	Government Central Press, Bombay.
315	Control of Citrus Gummosis. Leaflet No. 7 (1931) of the Department of Agriculture, Bombay.	Ditto . .	Ditto.
316	Grape Diseases in the Bombay Presidency. Leaflet No. 8 (1931) of the Department of Agriculture, Bombay.	Ditto . .	Ditto.
317	Bordeaux Mixture. Leaflet No. 2 (1932) of the Department of Agriculture, Bombay.	Ditto . .	Ditto.
318	Control of the Wilt Disease in Betel Vines. Leaflet No. 3 (1933) of the Department of Agriculture, Bombay.	Ditto . .	Ditto.
319	Cumin Powdery Mildew in Bombay. Bulletin No. 169 (1932) of the Department of Agriculture, Bombay. Price, As. 3.	B. N. Uppal and M. K. Desai.	Ditto.
320	Potato Blight *Phytophthora infestans* (Mont) De Bary (English and Bengali). Leaflet No. 1 of 1932 of the Department of Agriculture, Bengal.	Issued by the Department of Agriculture, Bengal.	Bengal Secretariat Book Depot, Calcutta.
321	Leaflet on Sugarcane Mosaic (Hindi and Urdu).	P. K. Dey . . .	Superintendent, Government Printing and Stationery, United Provinces, Allahabad.

List of Agricultural Publications in India during 1931-33—contd.

No.	Title	Author	Where published
	PLANT DISEASES—*concld.*		
322	Bordeau Mixture and its Preparation. Leaflet No. 94. of the Department of Agriculture, Punjab.	Issued by the Department of Agriculture, Punjab.	Government Printing, Punjab, Lahore.
323	On Citrus Canker and its Control. Leaflet No. 101 of the Department of Agriculture, Punjab.	Ditto . .	Ditto.
324	Some Important Diseases of Citrus Plants (Malta, *Sangtra* Lemon, etc.) and their control measures.	Ditto . .	Ditto.
325	Insect and Fungus Diseases of Sugarcane. Bulletin No. 12 (1932) of the Department of Agriculture, Bihar and Orissa.	Issued by the Department of Agriculture, Bihar and Orissa.	Government Press, Bihar and Orissa, Patna.
326	A Leaflet on Striga sp. 'Talap' or 'Agya' on Sugarcane (English, Hindi and Marathi).	Issued by the Department of Agriculture, Central Provinces.	Government Printing, Central Provinces, Nagpur.
327	A Leaflet on the Control of the Foot-rot Disease of *Pan* in the Central Provinces. (English, Hindi and Marathi).	Ditto . .	Ditto.
328	A Leaflet on Foot-rot Disease of Wheat in the Central Provinces and its Control. (English, Hindi and Marathi).	Ditto . .	Ditto.
329	Betel Vine Disease. (English, Bengali, Assamese and Khersi). Leaflet No. 4 of 1931 of the Department of Agriculture, Assam.	Issued by the Department of Agriculture, Assam.	Government Press, Shillong.
330	Orobanche on Tobacco . .	Issued by the Department of Agriculture, North-West Frontier Province.	Government Printing and Stationery, North-West Frontier Province, Peshawar.
331	A Statistical Study of Varietal Resistance to Root Disease (wilt) of Coconut Palms. Leaflet of the Department of Agriculture, Travancore.	Issued by the Department of Agriculture, Travancore.	Travancore State Press.
332	Diseases of the Coconut Palm. Leaflet of the Department of Agriculture, Travancore.	Ditto . .	Ditto.

List of Agricultural Publications in India during 1931-33—contd.

No.	Title	Author	Where published
	PLANT PESTS		
333	Life-histories of Indian Micro-Lepidoptera, Second Series: Alucitidae, Pterophoridae, Torticina and Gelechiadae (Scientific Monograph No. 2 of the Imperial Council of Agricultural Research). Price, Rs. 3-4-0 or 5*s.* 6*d.*	T. Bainbrigge Fletcher .	Manager of Publications, Civil Lines, Delhi.
334	Life-histories of Indian Micro-lepidoptera, Second Series: Cosmopterygidae to Neopseustidae. (Scientific Monograph No. 4 of the Imperial Council of Agricultural Research. Price, Rs. 3-4 or 5*s.* 6*d.*	Ditto . .	Ditto.
335	Alucitidae. Catalogue of Indian Insects, Part 20. Price, Rs. 1-6-0.	Ditto . .	Ditto.
336	Lycidae. Catalogue of Indian Insects, Part 21. Price, Rs. 1-2-0.	R. Kleine . . .	Ditto.
337	Phalomiadae and Chliotanotidae. Catalogue of Indian Insects, Part 22. Price, As. 6 or 8*d.*	T. Bainbrigge Fletcher .	Ditto.
338	The Deccan Grasshopper (English, Tamil, Telugu, Kanarese and Malayalam). Leaflet No. 39 of the Department of Agriculture, Madras.	T. V. Ramakrishna Ayyar	Government Press, Madras.
339	The Swarming Caterpillar of Paddy (English, Tamil, Telugu, Kanarese and Malayalam). Leaflet No. 40 of the Department of Agriculture, Madras.	Ditto . .	Ditto.
340	The Rice Bug (English, Tamil, Telugu, Kanarese and Malayalam). Leaflet No. 41 of the Department of Agriculture, Madras.	Ditto . .	Ditto.
341	The Rice Hispa (English, Tamil, Telugu, Kanarese and Malayalam). Leaflet No. 42 of the Department of Agriculture, Madras.	Ditto . .	Ditto.
342	Control of Rice Grasshopper in Malabar (Malayalam). Leaflet No. 44 of the Department of Agriculture, Madras.	Issued by the Department of Agriculture, Madras.	Ditto.

List of Agricultural Publications in India during 1931-33—contd.

No.	Title	Author	Where published
	PLANT PESTS—*contd.*		
343	The Paddy Grasshopper and its Control (English, Tamil, Telugu, Kanarese and Malayalam). Leaflet No. 48 of the Department of Agriculture, Madras.	T. V. Ramakrishna Ayyar	Government Press, Madras.
344	Insects affecting the Paddy Plants in South India. Bulletin No. 25 of the Department of Agriculture, Madras.	Ditto . .	Ditto.
345	Insect affecting Tobacco in South India. Bulletin No. 26 of the Department of Agriculture, Madras.	Ditto . .	Ditto.
346	Annotated List of Insects affecting the important cultivated plants in South India. Bulletin No. 27 of the Department of Agriculture, Madras.	Ditto . .	Ditto.
347	Insects affecting the Cotton Plant in South India. Bulletin No. 28 of the Department of Agriculture, Madras. Price, As. 2.	Ditto . .	Ditto.
348	Red Hairy Caterpillar Pest (English, Tamil, Telugu and Kanarese). Leaflet No. 2 (revised) of the Department of Agriculture, Madras.	Issued by the Department of Agriculture, Madras.	Ditto.
349	Some Common Insecticides (English, Tamil, Telugu, Kanarese and Malayalam). Pamphlet No. 5 of the Department of Agriculture, Madras.	T. V. Ramakrishna Ayyar	Ditto.
350	Green Fly or Aphis on Plants. Leaflet No. 5 (1932) of the Department of Agriculture, Bombay.	Issued by the Department of Agriculture, Bombay.	Government Central Press, Bombay.
351	Protection of Crops from Wingless Grasshoppers. Leaflet No. 9 (1932) of the Department of Agriculture, Bombay.	Ditto . .	Ditto.
352	Paddy Store Moth (Surma) and its Control. Leaflet No. 20 (1932) of the Department of Agriculture, Bombay.	Ditto . .	Ditto.
353	Some Insecticides, Fungicides and Appliances. Leaflet No. 3 (1933) of the Department of Agriculture Bombay.	Ditto . .	Ditto.

List of Agricultural Publications in India during 1931-33—contd.

No.	Title	Author	Where published
	PLANT PESTS—*contd.*		
354	Short Notes on two more Injurious Sugarcane Borers of Bengal (English and Bengali). Leaflet No. 7 of the Department of Agriculture, Bengal.	Issued by the Department of Agriculture, Bengal.	Bengal Secretariat Book Depot, Calcutta.
355	Notes on Rice Grasshopper (English and Bengali). Leaflet No. 8 of the Bengal Department of Agriculture.	Ditto . .	Ditto.
356	Damage caused by Insects on some commonly grown Fruits in the Plains of the United Provinces. Control Methods and Materials. Fruit Series No. 3 of the Department of Agriculture, United Provinces.	P. B. Richards . .	Government Printing and Stationery, United Provinces, Allahabad.
357	Note on the Field Rats in the United Provinces (English, Urdu and Hindi).	Ditto . .	Ditto.
358	A Note on the Flame-Thrower .	Khan A. Rahman . .	Government Printing, Punjab, Lahore.
359	Fruit Flies. Leaflet No. 102 of the Department of Agriculture, Punjab.	Issued by the Department of Agriculture, Punjab.	Ditto.
360	Insect and Fungus Diseases of Sugarcane. Bulletin No. 12 (1932) of the Department of Agriculture, Bihar and Orissa.	Issued by the Department of Agriculture, Bihar and Orissa.	Government Press, Bihar and Orissa, Patna.
361	A Short Note on Field Rats and How to Control them (English and Marathi).	Issued by the Department of Agriculture, Central Provinces.	Government Printing, Central Provinces, Nagpur.
362	A Note on Insects which attacked Sugarcane Crop in *Betul* and the Remedial Measures adopted to control them (English, Hindi and Marathi).	Ditto . .	Ditto.
363	Pink Bollworm in Cotton (English, Hindi and Marathi). Leaflet of the Department of Agriculture, Central Provinces.	Ditto . .	Ditto.
364	The Potato Epilachna Beetle. Mysore Department of Agriculture, Entomological Series. Bulletin No. 9.	Issued by the Department of Agriculture, Mysore.	Mysore State Press, Bangalore.

List of Agricultural Publications in India during 1931-33—contd.

No.	Title	Author	Where published
	PLANT PESTS—*concld.*		
365	The Potato Beetle—a Serious Pest of the Potato Crop (Kannada and English). Circular No. 49 of the Department of Agriculture, Mysore.	Issued by the Department of Agriculture, Mysore.	Mysore State Press, Bangalore.
	VETERINARY SCIENCE AND ANIMAL HUSBANDRY		
366	*Agriculture and Livestock in India*—(Bi-monthly), Vol. I, parts 4, 5 and 6; Vol. II, parts 1 to 6, Vol. III, parts 1, 2 and 3. Annual subscription Rs. 6 or 9*s.* 9*d.* Price per part Rs. 2 or 3*s.* 6*d.*	Issued under the authority of the Imperial Council of Agricultural Research.	Manager of Publications, Civil Lines, Delhi.
367	Grass Farming in Coimbatore District (English and Tamil). Bulletin No. 23 of the Department of Agriculture, Madras.	D. G. Munro . . .	Government Press, Madras.
368	South Indian Fodders. Bulletin No. 33 of the Department of Agriculture, Madras.	Issued by the Department of Agriculture, Madras.	Ditto.
369	Note on *Ragi* Silage in Coimbatore District (English and Tamil). Note No. 5 of the Department of Agriculture, Madras.	K. Gopalakrishna Raju .	Ditto.
370	Conditions to be fulfilled for the Grant of Premium for Breeding Bulls (English, Tamil, Telugu, Malayalam and Kanarese). Leaflet No. 2 of the Department of Agriculture, Madras.	Issued by the Department of Agriculture, Madras.	Ditto.
371	Feed and work your cow (English, Tamil, Telugu, Kanarese and Malayalam). Broadhint of the Department of Agriculture, Madras.	R. W. Littlewood .	Ditto.
372	Dedication of Breeding Bulls of Ongole Breed (English, Tamil, Telugu, Kanarese and Malayalam). Broadhint No. 8 of the Department of Agriculture, Madras.	Ditto . .	Ditto.
373	Institution of Prizes for calves born to Premium Bulls (English, Tamil, Telugu, Kanarese and Malayalam). Leaflet No. 49 of the Department of Agriculture, Madras.	S. V. Ramamurty . .	Ditto.

List of Agricultural Publications in India during 1931-33—contd.

No.	Title	Author	Where published
	VETERINARY SCIENCE AND ANIMAL HUSBANDRY—*contd.*		
374	Sale of Bull-Calves. Leaflet No. 10 (1931) of the Department of Agriculture, Bombay.	Issued by the Department of Agriculture, Bombay.	Government Central Press, Bombay.
375	How to feed cattle when at work Leaflet No. 16 (1932) of the Department of Agriculture, Bombay.	Ditto . .	Ditto.
376	How to feed cattle when in Milk Leaflet No. 17 (1932) of the Department of Agriculture, Bombay.	Ditto . .	Ditto.
377	How to feed cattle when at rest. Leaflet No. 18 (1932) of the Department of Agriculture, Bombay.	Ditto . .	Ditto.
378	Feeding of Poultry. Leaflet No. 19 (1932) of the Department of Agriculture, Bombay.	Ditto . .	Ditto.
379	Grass Land Problems in Western India. Bulletin No. 171 (1932) of the Department of Agriculture, Bombay. Price As. 3.	W. Burns, L. B. Kulkarni and S. R. Godbole.	Ditto.
380	Emergency Fodders. Leaflet No. 4 (1932) of the Department of Agriculture, Bombay.	Issued by the Department of Agriculture, Bombay.	Ditto.
381	Napier Grass. Leaflet No. 10 of the Department of Agriculture, Bengal.	Issued by the Department of Agriculture, Bengal.	Bengal Secretariat Book Depot, Calcutta.
382	Sunflower—*Helianthus annus* (var. *Suraj-mukhi*), an all the year round Fodder Crop (English and Vernacular). Veterinary Bulletin No. 1 (1933) Animal Husbandry of the Department of Agriculture, Punjab.	W. S. Read . . .	Government Printing, Punjab, Lahore.
383	Animal Report of the Poultry Expert to Government, Punjab, Gurdaspur for the year ending 30th June 1930. Price As. 2.	Issued by the Department of Agriculture, Punjab.	Ditto.
384	Sudan Grass—a new Fodder Crop for the Punjab. Leaflet No. 94 of the Department of Agriculture, Punjab.	Ditto . .	Ditto.

List of Agricultural Publications in India during 1931-33—contd.

No.	Title	Author	Where published
	VETERINARY SCIENCE AND ANIMAL HUSBANDRY—*contd.*		
385	Cowpeas as Fodder. Leaflet No. 97 of the Department of Agriculture, Punjab.	Issued by the Department of Agriculture, Punjab.	Government Printing, Punjab, Lahore.
386	Economic Value of Inoculation for Berseem. Leaflet No. 98 of the Department of Agriculture, Punjab.	Ditto . .	Ditto.
387	List of Horse and Cattle Fairs and Shows in the Punjab and Punjab States during the year 1931-32.	Issued by the Director of Veterinary Services, Punjab.	Ditto.
388	List of Horse and Cattle Fairs and Shows in the Punjab and Punjab States during the year 1932-33.	Ditto . .	Ditto.
389	A History and Guide to Government Cattle Farm, Hissar.	W. S. Read . . .	Ditto.
390	Poultry Breeding. Leaflet No. 103 of the Department of Agriculture, Punjab.	Issued by the Director, Veterinary Services, Punjab, Lahore.	Ditto.
391	Hints on Breeding of Cattle. Leaflet No. 2 (1932) of the Veterinary Department of Burma.	Issued by the Veterinary Department, Burma.	Government Printing and Stationery, Burma.
392	Cattle Sheds. Leaflet No. 4 (1932) of the Veterinary Department, Burma.	Ditto . .	Ditto.
393	Note on Cattle Question in Bihar and Orissa. Bulletin No. 1 (1932) of the Department of Agriculture, Bihar and Orissa.	Issued by the Department of Agriculture, Bihar and Orissa.	Government Printing, Bihar and Orissa, Patna.
394	A Preliminary Note on the Cultivation of Berseem in Chota Nagpur. Bulletin No. 7 (1932) of the Department of Agriculture, Bihar and Orissa.	Ditto . .	Ditto.
395	Care and Management in Dairy Herd. Bulletin No. 14 (1932) of the Department of Agriculture, Bihar and Orissa.	Ditto . .	Ditto.
396	The Scientific Feeding of Animals. Leaflet of the Department of Agriculture, Travancore.	Issued by the Department of Agriculture, Travancore.	Travancore State Press.
397	Cattle Feeding. Leaflet of the Department of Agriculture, Travancore.	Ditto . .	Ditto.

List of Agricultural Publications in India during 1931-33—contd.

No.	Title	Author	Where published
	VETERINARY SCIENCE AND ANIMAL HUSBANDRY—*contd.*		
398	*The Indian Journal of Veterinary Science and Animal Husbandry*, Vol. I, parts 3 and 4; Vol. II, parts 1 to 4 and Vol. III, parts 1 and 2. Annual subscription Rs. 6 or 9*s.* 9*d.*	Issued under the Authority of the Imperial Council of Agricultural Research.	Manager of Publications. Civil Lines, Delhi.
399	*The Indian Veterinary Journal* (The Journal of the All-India Veterinary Association) Quarterly. Annual Subscription Rs. 4 or 6*s.* 4*d.* for members and students, Rs. 8 or 10*s.* for others.	P. Srinivas Rao . .	Peoples' Printing and Publishing House Ltd., Triplicane, Madras.
400	*The United Provinces Veterinary Magazine* (English and Urdu). Monthly. Issued free to Members of the United Provinces Veterinary Association.	R. K. Nath . .	Standard Printing Works, Lucknow.
401	Annual Report of the Imperial Institute of Veterinary Research, Muktesar-Kumaun for the year ending 31st March 1931. Price Rs. 1-10 or 2*s.* 9*d.*	Issued by the Director, Imperial Institute of Veterinary Research, Muktesar.	Manager of Publications, Civil Lines, Delhi.
402	Annual Report of the Imperial Institute of Veterinary Research, Muktesar-Kumaun for the year ending 31st March 1932. Price, Re. 1-8-0 or 2*s.* 6*d.*	Ditto . .	Ditto.
403	Annual Administration Report of the Madras Civil Veterinary Department for the year 1930-31. Price, Re. 1-4-0.	Issued by the Civil Veterinary Department, Madras.	Government Press, Madras.
404	Annual Administration Report of the Madras Civil Veterinary Department for the year 1931-32.	Ditto . .	Ditto.
405	Annual Administration Reports of the Bombay Veterinary College, Bombay City and Harbour Veterinary Department and Civil Veterinary Department in the Bombay Presidency (including Sind) for the year 1930-31. Price, As. 3 or 4*d.*	Issued by the Civil Veterinary Department, Bombay.	Government Central Press, Bombay.

List of Agricultural Publications in India during 1931-33—contd.

No.	Title	Author	Where published
	VETERINARY SCIENCE AND ANIMAL HUSBANDRY—*contd.*		
406	Annual Administration Reports of the Bombay Veterinary College, Bombay City and Harbour Veterinary Department and Civil Veterinary Department in the Bombay Presidency (including Sind) for the year 1931-32. Price As. 3 or 4*d.*	Issued by the Civil Veterinary Department, Bombay.	Government Central Press, Bombay.
407	Annual Reports of the Civil Veterinary Department, Bengal and Bengal Veterinary College for the year 1930-31.	Issued by the Civil Veterinary Department, Bengal.	Bengal Secretariat Book Depot, Calcutta.
408	Annual Reports of the Civil Veterinary Department, Bengal and Bengal Veterinary College for the year 1931-32. Price As. 4 or 6*d.*	Ditto . .	Ditto.
409	Annual Report on the Civil Veterinary Department, United Provinces for the year 1930-31. Price, As. 12.	Issued by the Civil Veterinary Department, United Provinces.	Superintendent, Printing and Stationery, United Provinces, Allahabad.
410	Annual Report of the Civil Veterinary Department, United Provinces for the year 1931-32. Price Re. 1.	Ditto . .	Ditto.
411	An Investigation into the Control of *Fascioliasis* in Cattle.	S. Udam Singh under the direction of S. G. M. Hickey.	Ditto.
412	Annual Report of the Civil Veterinary Department, Punjab for the year 1930-31. Price Rs. 2-4 or 3*s.* 5*d.*	Issued by the Director of Veterinary Services, Punjab.	Government Printing, Punjab, Lahore.
413	Annual Report of the Civil Veterinary Department, Punjab for the year 1931-32. Price Rs. 2-4 or 3*s.* 5*d.*	Ditto . .	Ditto.
414	Use of Indigenous Drugs in Veterinary Practice. Bulletin No. 21 of the Punjab Veterinary Department.	S. Mool Singh . .	Ditto.
415	Prospectus of the Punjab Veterinary College, Lahore, 1932.	Issued by the Director of Veterinary Services, Punjab.	Ditto.
416	Prospectus of the Punjab Veterinary College, Lahore for the Session 1933-34.	Ditto . .	Ditto.

List of Agricultural Publications in India during 1931-33—contd.

No.	Title	Author	Where published
	VETERINARY SCIENCE AND ANIMAL HUSBANDRY—*contd.*		
417	Report on the Veterinary Department, Burma for the year ending 31st March 1931. Price, Rs. 2 or 3*s*.	Issued by the Civil Veterinary Department, Burma.	Government Printing and Stationery, Burma, Rangoon.
418	Report on the Veterinary Department, Burma for the year ending 31st March 1932. Price, Rs. 2 or 3*s*.	Ditto . .	Ditto.
419	Instructions for the use of Anthrax Vaccine in Animals (Revised). Leaflet No. 1 (1930) of the Veterinary Department, Burma.	Ditto . .	Ditto.
420	Elementary Microbiology (Burmese).	Issued by the Director of Veterinary Services, Burma.	Ditto.
421	Handbook of Papers on Veterinary Subjects (Burmese).	Ditto . .	Ditto.
422	On Rinderpest (English and Burmese). Leaflet No. 1 (1931) of the Civil Veterinary Department, Burma.	Ditto . .	Ditto.
423	On Foot and Mouth Disease (English and Burmese), Leaflet No. 2 (1931) of the Civil Veterinary Department, Burma.	Ditto . .	Ditto.
424	Glanders. Leaflet No. 1 (1932) of the Veterinary Department, Burma.	Ditto	Ditto.
425	Stomach Worms in Sheep. Leaflet No. 3 (1932) of the Veterinary Department, Burma.	Ditto . .	Ditto.
426	Cow Pox (Veriola—Vaccine). Leaflet No. 5 (1932) of the Veterinary Department, Burma.	Ditto . .	Ditto.
427	Mange (Scabies, itch). Leaflet No. 6 (1932) of the Veterinary Department, Burma.	Ditto . .	Ditto.
428	General Measures for dealing with the Contagious Diseases. Leaflet No. 7 (1932) of the Veterinary Department, Burma.	Ditto . .	Ditto.

List of Agricultural Publications in India during 1931-33—contd.

No.	Title	Author	Where published
	VETERINARY SCIENCE AND ANIMAL HUSBANDRY—*contd.*		
429	Diseases which caused many Deaths in Cattle at the beginning of the Monsoon. Leaflet No. 8 (1932) of the Veterinary Department, Burma.	Issued by the Director of Veterinary Services, Burma.	Government Printing and Stationery, Burma, Rangoon.
430	Goat Pox and Sheep Pox. Leaflet No. 9 (1932) of the Veterinary Department, Burma.	Ditto . .	Ditto.
431	Spread of Contagious Disease as a result of Animal Movements in Township. Leaflet No. 10 (1932) of the Vetrinary Department, Burma.	Ditto . .	Ditto.
432	Prevention of Contagious Disease in Animals by inoculations. Leaflet No. 11 (1932) of the Veterinary Department, Burma.	Ditto . .	Ditto.
433	Prevention of Disease in Animals by the Proper Disposal of Carcases. Leaflet No. 12 (1932) of the Veterinary Department, Burma.	Ditto . .	Ditto.
434	Annual Report of the Civil Veterinary Department, Bihar and Orissa for the year 1930-31. Price Re. 1.	Issued by the Civil Veterinary Department, Bihar and Orissa.	Government Printing, Bihar and Orissa, Patna.
435	Annual Report of the Civil Veterinary Department, Bihar and Orissa for the year 1931-32. Price Re. 1-3.	Ditto . .	Ditto.
436	Annual Report on the Working of the Civil Veterinary Department of the Central Provinces and Berar for the year ending 31st March 1931. Price Re. 1-8-0.	Issued by the Civil Veterinary Department, Central Provinces.	Government Printing, Central Provinces, Nagpur.
437	Annual Report on the Working of the Civil Veterinary Department of the Central Provinces and Berar for the year ending 31st March 1932. Price As. 15.	Ditto . .	Ditto.
438	Some Experiments in Rinderpest Vaccination. Active Immunization of Indian Plains Cattle by Inoculation with Goat-adopted Virus alone in Field Conditions.	Major R. F. Stirling .	Ditto.

List of Agricultural Publications in India during 1931-33—concld.

No.	Title	Author	Where published
	VETERINARY SCIENCE AND ANIMAL HUSBANDRY—*concld.*		
439	*Report of the Civil Veterinary Department, Assam for the year 1930-31. Price As. 8 or 9d.*	Issued by the Civil Veterinary Department, Assam.	Assam Government Press, Shillong.
440	Report of the Civil Veterinary Department, Assam for the year 1931-32. Price As. 12 or 1*s.* 2*d.*	Ditto . .	Ditto.
441	Report on the Civil Veterinary Department, North-West Frontier Province for the year 1930-31. Price Re. 1-11 or 3*s.*	Issued by the Civil Veterinary Department, North-West Frontier Province.	Government Printing and Stationery, North-West Frontier Province, Peshawar.
442	Report on the Civil Veterinary Department of the North-West Frontier Province for 1931-32. Price Re. 1-14 or 3*s.* 3*d.*	Ditto . .	Ditto.
443	The Annual Report of the Mysore Civil Veterinary Department for the year 1930-31.	Issued by the Civil Veterinary Department, Mysore.	Government Press, Banglore.
444	The Annual Report of the Mysore Civil Veterinary Department for the year 1931-32.	Ditto . .	Ditto.

APPENDIX XIV

Key to the Diagrammatic Map of Agricultural Stations

Research Institutes and Agricultural Colleges	Special or Subsidiary Research Stations and Research Farms	Main Experimental Farms	Small Farms, District Farms and Demonstration Farms	Seed Farms	Major Cattle-breeding and Dairying Farms	Subsidiary Cattle-breeding Farms
			IMPERIAL			
1. Pusa (Bihar and Orissa).	1. Bangalore (Mysore)				1. Pusa (Bihar and Orissa).	
	2 Coimbatore (Madras).				2. Karnal (Punjab)	
	3. Karnal—Botanical and Sugarcane Substations (Punjab).				3. Wellington (Madras).	
			MADRAS			
1. Coimbatore.	1. Anakapalle.		1. Samalkota.	1. Nanjanad.	1. Hosur,	1. Guntur.
	2. Maruteru.		2. Palakuppam.			
	3. Nandyal.		3. Vellalore.			
	4. Hagari.		4. Talliparamba.			
	5. Palur.		5. Pallicode.			
	6. Aduturai.		6. Nileshwar.			
	7. Koilpatti.					
	8. Burliar.					
	9. Coonoor.					
	10. Kallar.					
	11. Pattambi.					
	12. Kasargod.					
	13. Guntur.					

Key to the Diagrammatic Map of Agricultural Stations—contd.

Research Institutes and Agricultural Colleges	Special or Subsidiary Research Stations and Research Farms	Main Experimental Farms	Small Farms, District Farms and Demonstration Farms	Seed Farms	Major Cattle-breeding and Dairying Farms	Subsidiary Cattle-breeding Farms
			BOMBAY			
			PRESIDENCY PROPER.			
1. Poona.	1. Surat.	1. Ratnagiri.	1. Kumta.	1. Bhadgaon.	1. Chharodi.	1. Tegur.
	2. Nadiad.	2. Dhulia.	2. Mugad.	2. Gadag.	2. Bankapur.	2. Sangvi.
	3. Dhulia.	3. Jalgaon.	3. Gokak Canal.			3. Surat.
	4. Dharwar.	4. Surat.	4. Hatkhamba.			
	5. Karjat.		5. Mohol.			
	6. Padegaon.		6. Koppargaon.			
			7. Broach.			
			8. Bohad.			
			9. Viramgam.			
			SIND			
2. Sakrand.	7 .Larkana.	5. Mirpurkhas.	10. Dadu.	3. Mirpurkhas.		
			11. Oderolal.			
			12. Lundo.			
			13. Padidam.			
			14. Nasirabad.			
			15. Shahdadkote.			
			BENGAL			
1. Dacca.	1. Berhampore.	1. Chinsura.	1. Burdwan.		1. Rangpur.	....
	2. Rangpur.	2. Rajshahi.	2. Berhampore.			
	3. Kurseong.		3. Bankura.			

	4. Kalimpong.		4. Suri.		
			5. Krishnagar.		
			6. Jessore.		
			7. Gosaba.		
			8. Faridpur.		
			9. Rangamati.		
			10. Comilla.		
			11. Barisal.		
			12. Kishoreganj.		
			13. Mymensingh.		
			14. Pabna.		
			15. Dhanbari.		
			16. Bogra.		
			17. Jamalpur.		
			18. Rangpur.		
			19. Malda.		
			20. Dinajpur.		
			21. Mainaguri.		
			UNITED PROVINCES		
1. Cawnpore.	1. Shahjahanpore.	1. Gorakhpore.	1. Benares.	1. Nagawan.	1. Muttra.
	2. Muttra.	2. Partabgarh.	2. Fyzabad.	2. Kalianpur.	2. Kheri.
	3. Cawnpore.	3. Muzaffarnagar.	3. Etawah.	3. Kalai.	
		4. Jeolikote.	4. Mainpuri.		
			5. Bichpuri.		
			6. Hardoi.		
			7. Bahraich.		
			8. Bulandshahr.		
			9. Jaitpur.		

Key to the Diagrammatic Map of Agricultural Stations—contd.

Research Institutes and Agricultural Colleges	Special or Subsidiary Research Stations and Research Farms	Main Experimental Farms	Small Farms, District Farms and Demonstration Farms	Seed Farms	Major Cattle-breeding and Dairying Farms	Subsidiary Cattle-breeding Farms
			UNITED PROVINCES —*contd.*			
			10. Budaun.			
			11. Nagina.			
			12. Nawabganj.			
			13. Meerut.			
			14. Atarra.			
			15. Hydergarh (Bara Banki).			
			16. Bara Banki.			
			17. Unao.			
			18. Kalianpur (Cawnpore).			
			19. Kalai (Aligarh).			
			PUNJAB			
1. Lyallpur.	1. Risalewala.	1. Lyallpur.	1. Gurgaon.	1. Fatna.	1. Hissar.	
		2. Montgomery.	2. Rohtak.	2. Shergarh.		
		3. Hansi.	3. Karnal.	3. Viharl.		
		4. Sirsa.	4. Ambala.	4. Risalewala.		
		5. Jullundur.	5. Ludhiana.	5. Chillianwala.		
		6. Gurdaspur.	6. Beas.	6. Sargodha.		
		7. Kala Shah Kaku.	7. Kangra.	7. Multan.		
		8. Rawalpindi.	8. Ferozepur.			
			9. Gujranwala.			
			10. Gujrat.			

			11. Jhang.		
			12. Mianwali.		
			13. Campbellpur.		
			14. Attari.		
			BURMA		
1. Mandalay.		1. Maungmya.	1. Paukkoung.	1. Chiba.	1. Tatkon.
		2. Hmawbi.	2. Sa-aing.	2. Kyehmon.	
		3. Mudon.	3. Kyaukpyu.	3. Singaing.	
		4. Akyab.		4. Pwinbya	
		5. Allanmyo.		5. Magwe.	
		6. Pyinmana.		6. Pyu.	
		7. Mahlaing.		7. Paungde.	
		8. Kanbalu.		8. Henzada.	
				9. Pegu.	
				10. Maubin.	
				11. Thaton.	
				12. Padu.	
			BIHAR AND ORISSA		
1. Sabour.	1. Muzaffarpur (Sugarcane Research Station).	1. Kanke.	1. Balasore.		1. Kanke.
		2. Patna.	2. Anandpur.		2. Sepaya.
....	2. Sabour (Rice Research Station).	3. Sepaya.	3. Puri.		
		4. Cuttack.	4. Khurda.		
		5. Sabour.	5. Angul.		
			6. Purulia.		
			7. Gaya.		
			8. Netarhat.		
			9. Nawadah.		
			10. Jamui.		

Key to the Diagrammatic Map of Agricultural Stations—contd.

Research Institutes and Agricultural Colleges	Special or Subsidiary Research Stations and Research Farms	Main Experimental Farms	Small Farms, District Farms and Demonstration Farms	Seed Farms	Major Cattle-breeding and Dairying Farms	Subsidiary Cattle-breeding Farms
			BIHAR AND ORISSA —*contd.*			
			11. Banka.			
			12. Darbhanga.			
			13. Siwan.			
			14. Bikramgunj.			
			15. Siris.			
			16. Chianki.			
			17. Chaibasa.			
			18. Sambalpur.			
			CENTRAL PROVINCES			
1. Nagpur.	1. Akola.	1. Powarkhera.	1. Chhindwara.	1. Saugor.	1. Telinkheri.	1. Powarkhera.
	2. Raipur.	2. Adhartal.		2. Bilaspur.	2. Raigarh (Garhi).	2. Richai.
		3. Nagpur.		3. Chandkhuri.	3. Pendra.	3. Nagpur College Dairy Farm.
				4. Drug.	4. Ellichpur.	
				5. Seoni.	5. Bod.	
				6. Betul.		
				7. Khandwa.		
				8. Wara-Seoni.		
				9. Yeotmal.		
				10. Buldana.		
				11. Borgaon.		
			ASSAM			
1. Jorhat.		1. Karimganj.			1. Khanpara.	1. Upper Shillong.
		2. Upper Shillong.			2. Sylhet.	2. Jorhat.

		3. Titabor.				
		4. Jorhat.				
			NORTH-WEST FRONTIER PROVINCE			
		1. Tarnab.	1. Haripur.			
			2. Parachinar.			
			BALUCHISTAN			
	1. Quetta (Fruit Experiment Station).					
			HYDERABAD STATE			
1. Himayat Sagar.		1. Sangareddi.	1. Alir.			
2. Parbhani.		2. Raichur.	2. Mahbubnagar.		1. Hyderabad.	
		3. Rudrur.				
			MYSORE STATE			
1. Bangalore.		1. Hebbal.	1. Chickanhalli.	1. Mysore Irwin Canal Farm.	1. Ajjampur (Cattle-breeding Station).	
		2. Naggenhalli.	2. Hassan.	2. Kodihalli Farm.	2. Yellachi halli (Sheep Farm).	
		3. Hansur.	3. Ramkirishnapur.	3. Malligere Farm.		
		4. Marthur.		4. Satnur Farm (These are special large-scale sugar-cane growing farms).		
		5. Balehonnur.				
		6. Babbur.				
			BARODA STATE			
	1. Baroda (Cotton root-rot research scheme).	1. Baroda.				1. Makarpura.
		2. Jagudan.				
		3. Amreli.				
			TRAVANCORE STATE			
1. Quilon.		1. Alleppey.	1. Alwaye.		1. Trivandrum.	
		2. Koni.	2. Oachira.			
		3. Nagercoil.	3. Vaikom.			

Key to the Diagrammatic Map of Agricultural Stations—concld.

Research Institutes and Agricultural Colleges	Special or Subsidiary Reserach Stations and Research Farms	Main Experimental Farms	Small Farms, District Farms and Demonstration Farms	Seed Farms	Major Cattle-breeding and Dairying Farms	Subsidiary Cattle-breeding Farms
			TRAVANCORE STATE —*contd.*			
			4. Kottarakara.			
			5. Puliyara.			
			6. Cape Comorin.			
			GWALIOR STATE			
	1. Gwalior.	1. Gwalior.		1. Gawlior.		1. Maharajpur (Gwalior).
	2. Ujjain.	2. Ujjain.		2. Ujjain.		2. Ujjain.
			KASHMIR STATE			
		1. Shalabagh, Srinagar (Pratap Model Farm).				
		2. Jammu (Golsamandar).				
			BHOPAL STATE			
1. Nabi Bagh.						
			PATIALA STATE			
1. Patiala.						
			NON-OFFICIAL			
Indore (Central India Institute of Plant Industry).						
Ranchi (Bihar and Orissa Lac Research Institute).						
Tocklai (Assam Indian Tea Association).	Nellacotta (Nilgiris U. P. A. S. I.).	Sidapur (Madras U. P. A. S. I.).	Borbhetta (Assam Indian Tea Association).			
	Mundakayam (Travancore U. P. A. S. I.).					

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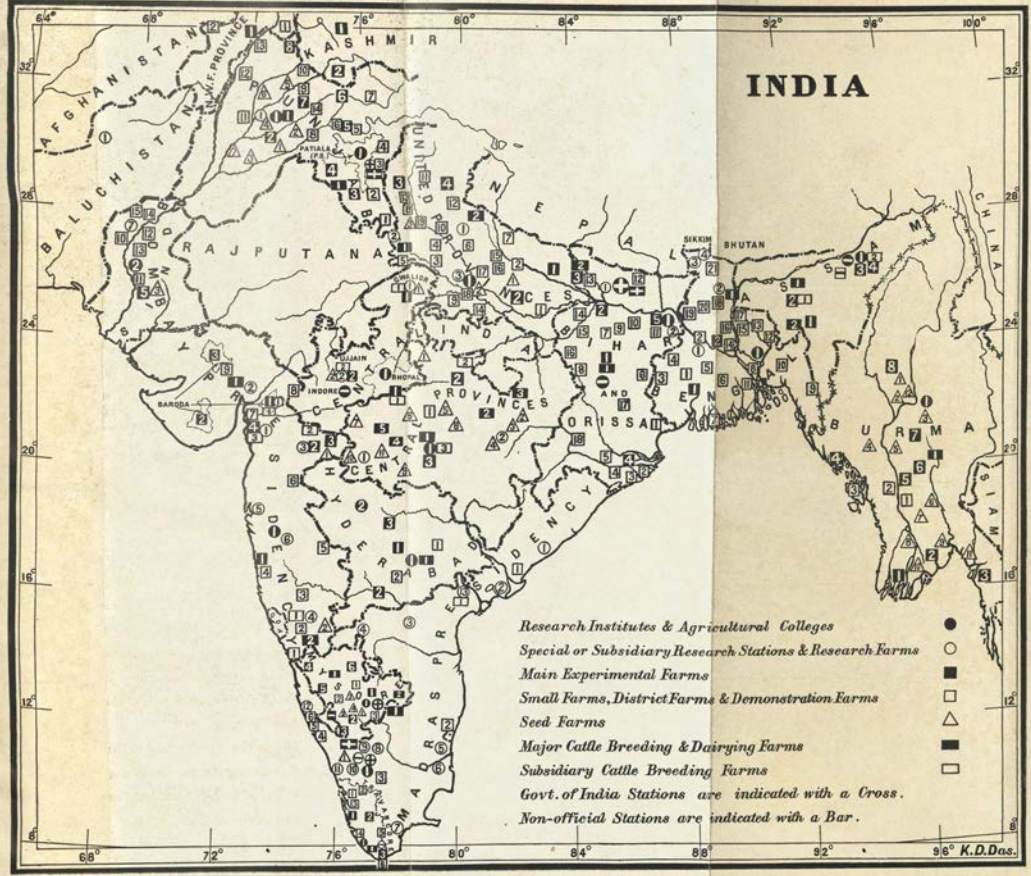
INDIA
AFGHANISTAN
BALUCHISTAN
N.W.F. PROVINCE
KASHMIR
PUNJAB
PATIALA
RAJPUTANA
SIND
NEPAL
SIKKIM
BHUTAN
ASSAM
CHINA
BENGAL
BIHAR AND ORISSA
CENTRAL PROVINCES
INDIA
BARODA
INDORE
BHOPAL
UJJAIN
HYDERABAD
MADRAS PRESIDENCY
BURMA
SIAM
Research Institutes & Agricultural Colleges
Special or Subsidiary Research Stations & Research Farms
Main Experimental Farms
Small Farms, District Farms & Demonstration Farms
Seed Farms
Major Cattle Breeding & Dairying Farms
Subsidiary Cattle Breeding Farms
Govt. of India Stations are indicated with a Cross.
Non-official Stations are indicated with a Bar.
K.D.Das.

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